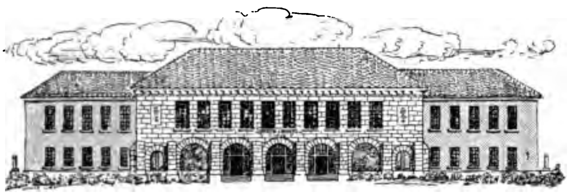
ELEMENTARY PHYSIOLOGY

JOHN · C · WILL



ELEMENTARY PHYSIOLOGY

INCLUDING

HYGIENE, A BRIEF SUMMARY OF BACTERIOLOGY, AND AN OUTLINE OF MEANS FOR AIDING THE INJURED, AND PREVENTING DISEASE

FOR ADVANCED GRADES

BY

JOHN CALVIN WILLIS, A.M., Ph.D., M.D.

AUTHOR OF "ESSENTIALS OF HEALTH" AND "OUTLINES OF PSYCHOLOGY"

NEW YORK ·:· CINCINNATI ·:· CHICAGO
AMERICAN BOOK COMPANY

WILLIS, ELEMENTARY PHYSIOLOGY.

E-P 2

PREFACE

THE author has endeavored to state the essential facts of physiology in the clearest possible way, and to develop from these facts some practical rules of health. Great effort has been put forth to make a text easy to read and to understand. There is more anatomy than is usual for texts of this grade, but there is no adequate understanding of the facts of physiology or the rules of hygiene without a fair knowledge of anatomy. Pains have been taken to explain fully the action of all important organs, so the most useful rules of hygiene may be clearly understood and applied. As far as possible, technical terms have been omitted, and the matter of the text expressed in the language of the average pupil in the advanced grades. Technical terms, when used at all, are explained where first used.

In the illustrations there is no effort at artistic effect, but, as far as possible, the subject is illustrated with clear, appropriate cuts. The illustrations of the text should be studied as carefully as the language. Detailed descriptions of the cuts, in most cases, have not been made.

Each chapter is provided with an "Outline Summary," which is designed as (1) an analysis of the matter of the chapter, (2) a summary, (3) a ready key to the material of the text, and (4) a practical lesson plan and order of work for both the student and class. The student should read carefully the outline summary both before and after

studying the chapter. A convenient list of questions is appended to most chapters.

The "Practical Experiments" (see page 361), may be worked out without any expensive apparatus except a microscope. As far as possible, pupils should examine specimens of subjects studied, and should be taught to construct simple apparatus and to make drawings to illustrate the essential facts of the subject.

To learn to live correctly is the chief purpose of the study of the human body; accordingly, the subject of hygiene has been given the most prominent place in this work. No organ has been described, and no process stated, except to lay the foundation for a statement of some law of correct living. Instead of putting the laws of hygiene in the usual form, the author has adopted the simple plan of suggesting the rule as the necessary outcome of physiological action. It is shown to be the adapting of natural means to well-known ends.

The treatment of the subject of alcohol embodies the results of the latest research. Alcohol is not abused, but its effects, good and bad, are clearly pointed out.

Great effort has been put forth to make a useful book. Every page was written in full view of the practical needs of the schoolroom and the private student.

"As is the cell, so is the body." The entire work is essentially a study of the life of the cell.

The author has made free use of most of the works upon this subject. Originality is not claimed. If he has succeeded in placing the common facts of a beautiful science and a useful art within easy reach of the average student, his purpose is accomplished.

J. C. WILLIS.

TABLE OF CONTENTS

ELEMENTARY PHYSIOLOGY

CHAPTER I

INTRODUCTION

1. Why study our Bodies? — Long life is the result of obeying the laws of health. Good food, pure air, proper exercise, pleasant work, unbroken rest, cleanliness, and peace of mind are essential to health. Avoiding alcohol, tobacco, overwork, overeating, disease, and the extremes of heat and cold will lengthen the life of any one.

Most people die too young; the average of human life is below thirty-five years, and very few live longer than seventy years; instead of this most people should live a hundred years or more. The bodies of most healthy people grow until they are about forty years of age. By correct living one should be strong at eighty, not very feeble at ninety, and not old until nearly a hundred.

The majority of people are under size or have some deformity. Some infirmities are inherited, but most of them are the result of strain, deficiency, or disease. Nearly all diseases leave permanent effects. Improper nourishment and great extremes weaken the body or prevent proper growth. Nearly all of these conditions shorten life; to meet and overcome them, it is necessary to study the body as it appears in both health and disease.

2. Definition of Terms. — The three terms, *Anatomy*, *Physiology*, and *Hygiene*, occupy different fields in medi-

cine, but they have much in common; for convenience of study they are all included in the general term *physiology*, in this book.

Anatomy treats of the parts of the body. It describes these parts, shows how they are put together, and how they help each other. It is really a study of the *dead body*, and is best pursued by cutting the body to pieces and examining every organ. Anatomy, then, treats of the structure of the body.

Physiology treats of the *living body;* it explains how the parts of the body act, either alone or with each other, and of the life in the body by describing bodily functions.

Hygiene treats of health. It teaches how to nourish, clothe, use, and cleanse the body; also how to preserve the body, and to make its tissues good.

3. Cells. — The cell is the smallest unit of life in both the plant and the animal. A few can be seen with the naked eye, but most of them are so small that they may be seen only by means of a high-power microscope. Millions of these cells are found in a single muscle, or in a division of the brain. They vary in shape; some being round, some flat, and others threadlike (Fig. 1). Cells are bound together or held in place by a *connective tissue* which in some places appears as fine strings, and in other places as a sheath. Some cells exist alone, but most of them are bound together; they both aid and depend upon each other.

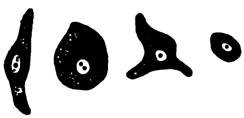


FIG. 1. — Cells.

The smallest animal known is composed of only one cell, and is only about $\frac{1}{10000}$ of an inch in diameter. It lives in moist earth, and is called *amœba* (Fig. 3); it has no head, arms, legs, eyes, ears, or mouth, but it can move and eat.

The amœba has an elastic body; it can put out a part of the body, take up a bit of food, wrap its body about the food and digest it. The amœba can extend a part of its body, then bring up the remainder, and thus walk. After growing to full size, the amœba divides, making two cells, or little animals. It can put any part of its body to a variety of uses, but no part has any special use. It is known to be an animal because it takes in oxygen and gives off a gas called carbon dioxide.

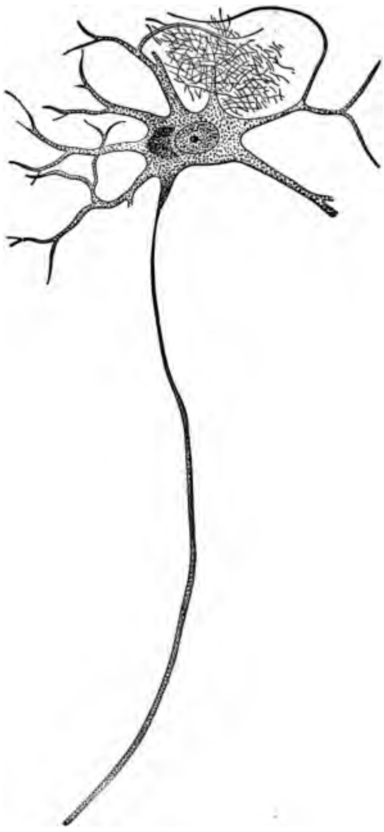


FIG. 2.—Nerve cell.

The smallest plants, too, are composed of only one cell. They are called *bacteria*, or germs. Some of them are useful, but others are harmful; some bacteria cause the dead bodies of animals and plants to decay and give up their elements to enrich the soil; others cause many dangerous diseases. Bacteria are the cause of typhoid fever, consumption, pneumonia, diphtheria, and other diseases; they cause, also, cholera in fowls and hogs, and glanders in horses. If people could learn to destroy bacteria, most diseases would cease to exist, and millions of lives would be saved. Bacteria are

so small that they can be seen only by means of the finest microscope.

New cells are formed by the division of old ones. The life of a plant or an animal begins as a single cell, and grows by cell division. Cells have the power of nutrition, by which they convert dead food into living tissues, and take up all the chemical substances necessary for the body. Cells are composed of water, albumin, fats, starch, sugar, and a few minerals.

The parts of a cell are (1) the cell wall, (2) protoplasm, (3) nucleus, (4) centrosomes. Each part is essential to the life and growth of the cell. The cell wall serves to hold the fluids of the cell in place. It may be thick or thin, and of various shapes.

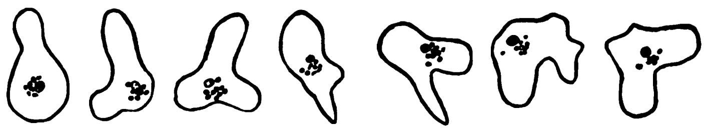


FIG. 3. — Diagrams of amœba.

The cell wall contains the cell substance, or protoplasm, like the white of an egg, a clear fluid, sometimes called the "physical basis of life." Within the protoplasm is the nucleus, a small body surrounded by a membrane, and containing two fluids and some smaller bodies called nucleoli. The nucleus is essential to the life of the cell; whenever the nucleus and protoplasm are separated they quickly degenerate. Centrosomes are small starlike bodies within the protoplasm. They usually appear in pairs, and play an important part in cell division.

Cell division is composed of several distinct steps. The first change is in the nucleus whose fibers form a number of threads and then break up into several small pieces, chromosomes, which are always of the same number

in animals of the same species ; the second change is seen in the centrosomes, which move away from each other, occupy places in opposite sides of the cell, and assume a starlike appearance but are still connected by fibers ; the third change is the disappearance of the membrane around the nucleus; in the fourth change the parts of the nucleus arrange themselves in a line between the centrosomes; then the chromosomes split into equal parts which surround the centrosomes ; in the sixth and last step a membrane divides the old cell, and the parts separate, a chromosome of the old cell becoming the nucleus of a new cell, and a centrosome remaining with each nucleus; these new cells separate, and each begins its particular work, as did the parent cell before it.

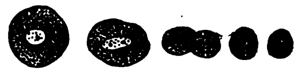


FIG. 4. — Cell division.

4. Tissues. — A group of cells joined together in a particular way and for a particular purpose is called a *tissue*, as bone, nervous, muscular, or fibrous tissue. These tissues differ in shape, color, hardness, and use. There are five primary tissues ; viz., *muscular*, *fibrous*, *nervous*, *epithelial*, and *osseous ;* from these all secondary tissues are derived.

5. Organs. — Two or more tissues united to do a given work make what is called an *organ;* this is properly applied to any part of the body that does a definite work. as the heart, the stomach, or the brain.

6. System. — A *system* is composed of two or more organs acting together to do a common work ; for instance, all the parts that coöperate to make the blood circulate are called the *circulatory* system ; other systems are the nervous, the digestive, and the respiratory.

7. Composition of the Body. — The body is supported by three agents: water, air, and food. Water constitutes about three fourths of the body; it exists in various forms, and combines with many other substances, thereby losing its identity; it also constitutes about three fourths of each cell, and is found in all tissues, even in bone, teeth, and cartilage. Air supplies the body with oxygen, which assists in making heat by a process called *oxidation*, much like the oxidation that takes place in a grate or furnace.

Foods are of three chief kinds: *proteids*, *sugar*, and *fat*. These have different names; proteids are called albumin, sugar and starch are called carbohydrates, and fats are called hydrocarbons. To these foods must be added a few minerals always needed in the body to keep it in good health. Foods should be of sufficient variety to contain all these parts, or all the tissues cannot be well nourished.

8. Motion, Nourishment, and Control. — The chief ends ot all vital action in the body are *motion*, *nourishment*, and *control;* if these three can be had in the proper proportion, the body is in a state of perfect health. In studying these pages, the three great ends must be kept in view. Everything taken into the body is for one or more of these ends, and every cell in the body works to aid one of these processes. Physiology is primarily a study of the human cell in its relation to motion, nourishment, and control.

QUESTIONS

1. How can a person increase the length of his life?
2. How do physiology and hygiene differ?
3. How do cells increase in size and number?
4. What are germs?
5. Define *tissue*, *organ*, and *system*.

CHAPTER II

THE FRAMEWORK

1. The Skeleton. — If all the muscles of the body were removed, a framework of bones would remain; these bones serve as a support for other parts of the body, and are called the *skeleton* (Fig. 5).

The human skeleton in the adult is made up of about two hundred classified bones, exclusive of the teeth.

2. Parts of Bone. — A bone is composed of four parts: (1) *periosteum*, (2) *compact tissue*, (3) *spongy tissue*, and (4) *marrow*. The periosteum is a thin membrane covering the entire bone except, sometimes, the ends that rest on cartilage. Under the periosteum is the compact tissue, which gives strength and shape to the bones; beneath the compact tissue there is usually a layer of spongy bone material, which is full of blood vessels. The spongy tissue usually surrounds a cavity, filled with a soft, oily substance called marrow, which consists mostly of fat.

3. Arrangement of Bone Substance. — The substance of bones is arranged in layers around little channels called *Haversian canals*. Within the layers around these canals are many small openings or lakes (*lacunæ*); from these, little channels (*canaliculi*) branch in every direction (Fig. 6).

4. Composition of Bone. — Bones are composed of (1) animal matter, a kind of gelatin, which makes the bone elastic and tough, and (2) mineral matter, which gives the bone firmness and strength. The composition of bone may be easily determined by two simple experi-

FIG. 5.—The skeleton.

ments. If a bone is burned until it is white, it will retain its size and shape, but will lose its former weight, tough-

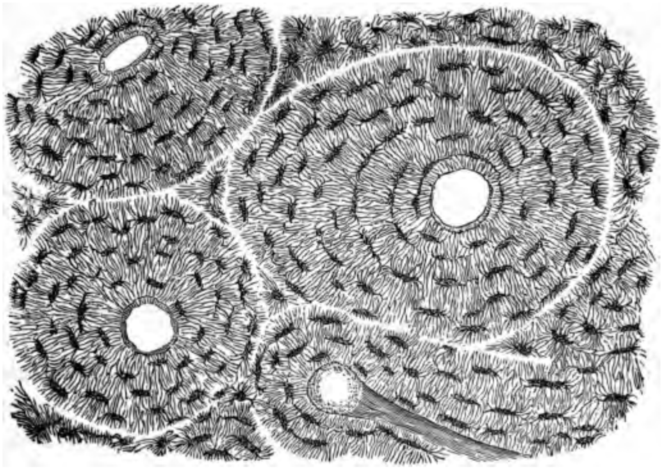


FIG. 6.—Section of bone, magnified, showing *lacunæ*, *canaliculi*, and Haversian canals.

ness, and elasticity, become brittle, and can be broken by a light stroke. The fire has burned the animal matter, but left the mineral. If a similar bone be put into a dilute acid and kept a few days, the acid will combine with the minerals in the bone, take away much of its weight, leaving the bone soft and flexible enough to tie in a knot. As heat removes animal matter, so acid removes mineral matter (Fig. 7).

FIG. 7.—A bone that has been soaked in acid.

5. Age of Bones. — The amount of animal and mineral matter depends upon the age and occupation of an individual. In children, where there is less weight and greater activity, bones are more flexible, difficult to break, and, if broken, unite more quickly. In adults, the amount of mineral matter is greater, and their bones are stronger; but they are much more brittle, and if broken, do not so readily unite. Nature has provided an abundance of animal matter in the bones of children, where great flexibility is required, and mineral matter in the bones of older persons, where great strength is needed.

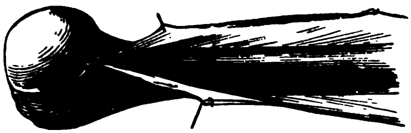


FIG. 8. — Bone and periosteum.

6. Covering of Bones. — Bones are covered with a thin membrane called the periosteum, which is thick in the bones of the young, but becomes thin and tough with age. The periosteum contains many small blood vessels and supplies much of the bone's nourishment. The periosteum may be easily removed from the bone of a young animal with a knife (Fig. 8).

7. Bone Marrow. — Long bones contain a long cavity in the center filled with a spongy substance called marrow; in the young it is reddish in color, but in old animals the color is somewhat yellow. Marrow consists mostly of fat and blood vessels, and supplies the bone with nourishment (Fig. 9).

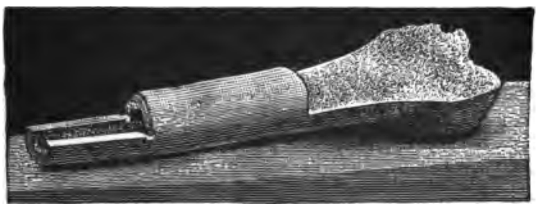


FIG. 9. — Structure of bone.

8. **Growth of Bones.** — In many of the joints there is a spongy, elastic substance called *cartilage*, or gristle. At first all bones are composed of animal matter, and its cells are gradually replaced by bone cells. In some bones the change from cartilage requires but a short time, while in other bones almost a lifetime is required. Cartilage begins to ossify, or turn to bone, at one or more points by the deposit of bone cells; this process continues until almost the whole bone becomes solid.

9. **Kinds of Bones.** — For convenience in study, bones are classified as *long*, *short*, *flat*, and *irregular*. Long bones consist of a shaft and two extremities, and act as levers; the bones of limbs belong to this class. Short bones are grouped and bound by ligaments, and are found where great strength is needed; bones of the ankle and wrist belong to this class. Flat bones afford much surface for the attachment of muscles, and protect internal organs, as most bones of the cranium, the shoulder blades, and ribs. Irregular bones are such as do not belong to the other class.

OUTLINE SUMMARY

1. *The Skeleton.* 1. Definition — the bony framework of the body.
   2. Number of bones — about two hundred separate bones.
2. *Parts of Bones.* 1. Periosteum — the covering of bones.
   2. Compact tissue — the layer which gives form and strength.
   3. Spongy tissue — a spongy bone containing blood vessels.
   4. Marrow — soft, oily substance which is mainly fat.
3. *Bone Substance.* 1. Matrix — bone substance arranged in layers.
   2. Haversian canals — little channels through the matrix.
   3. Lacunæ — small lakes, or openings, usually in rows.
   4. Canaliculi — little channels going out from the small lakes.
4. *Composition.* 1. Animal matter — a kind of gelatin which makes the bone tough and elastic.
   2. Mineral matter — which makes bone firm and strong.
5. *Age.* 1. The proportion — the amount of animal and mineral matter depends upon the age and work of a person.
   2. Parts at different ages — first animal matter in excess; then mineral matter.

6. *Covering*. 1. Membrane — the periosteum contains nutrient vessels.
   2. Removal — in young animals it can be removed with a knife.
7. *Marrow*. 1. Definition — the spongy substance in the hollow of the bone.
   2. Composition — mostly of fat and blood vessels.
8. *Growth*. 1. In infancy — it is at first cartilage, which ossifies.
   2. Rate — depends upon nutrition, occupation, and rest.
9. *Kinds* — bones are long, short, flat, and irregular.

QUESTIONS

1. What are the parts of bone? Arrangement of bone substance?
2. What is the difference between animal matter and mineral matter?
3. Describe the periosteum.
4. What is the function of marrow?
5. How does bone grow?

CHAPTER III

THE SKELETON

1. The Arrangement of Bones. — Bones are arranged in pairs, excepting the bones in the median line of the body, the teeth, bones of the internal ear, and the miscellaneous bones. In the median line, anterior and posterior, there are about thirty-four bones. About one hundred and sixty-six bones are arranged in pairs, and are on the sides of the body and head, or in the limbs.

2. How Bones are Named. — To study bones properly, it is necessary for all bones, joints, grooves, and ridges to have names. Most of the names are from the Latin and Greek languages, because these were the languages of science at the time bones were named. Almost every name has a meaning, and was chosen because of the shape, location, use, or general appearance of the bone.

3. Divisions of the Skeleton. — The parts of the skeleton are the *head*, *trunk*, and *extremities*. These parts have

other names; the bones of the head are sometimes called the skull, those of the trunk are called the thorax, and those of the extremities the leg and arm. These are the common names of these groups of bones; each bone, also, has a scientific and a common name.

FIG. 10.—The skull.

1. Frontal bone.
2. Parietal bone.
3. Temporal bone.
4. Sphenoid bone.
5. Ethmoid bone.
6. Occipital bone.
7. Superior maxillary (upper jaw) bone.
8. Malar bone.
9. Lachrymal bone.
10. Nasal bone.
11. Inferior maxillary (lower jaw) bone.

4. Bones of the Head. — Bones of the head, twenty-eight in number, are those of the *cranium*, *face*, and *ear*.

The cranium is made up of eight parts so joined as to form a strong box, which contains the brain. The names of the cranial bones are as follows: the *frontal* (one), forming the forehead; *temporal* (two), on sides of the head below; *parietal* (two), on sides of head, forming the top; *occipital*, forming the back and lower part of the head; *sphenoid*, constituting the base; and the *ethmoid*, situated between the cavities of the eyes.

There are fourteen facial bones, as follows: the *nasal* (two), forming bridge of nose; *malar* (two), cheek bones; *lachrymal* (two), at inner corner of eye cavities; *inferior turbinated* (two), in nose cavities; *palate* (two), back part

of roof of mouth; *superior maxillary* (two), upper jaw; *inferior maxillary* (one), the lower jaw; and *vomer* (one), between cavities of the nose.

The bones of the ear are the *malleus*, *incus*, and *stapes*, their common names being the hammer, anvil, and stirrup. These bones form a sort of chain in the middle ear.

5. **Bones of the Trunk.** — Three groups of fifty-seven bones make up the framework of the trunk; these groups are known as the *thorax*, the *spinal column*, and the *pelvis*.

The thorax incloses and protects the heart, lungs, and other important organs. It is comprised of the following bones: (1) *sternum*, (2) *clavicles*, (3) *scapulas*, and (4) *ribs*. The sternum is the breastbone, and in early life is composed of three parts which finally unite into one bone. The clavicles are the collar bones, and their chief work is to hold the shoulders in place; they are more frequently broken than any other bone in the body. The scapulas are the shoulder blades, used for forming the shoulder joint, and for the attachment of important muscles. There are twelve pairs of ribs; the upper seven pairs are attached to the sternum and spinal column, and are called the *true ribs;* the lower five pairs are called *false ribs*, two pairs of which are attached to the spinal column only, the front ends being free. The thorax has the general shape of a cone with the point upward.

The spinal column, or backbone, is composed of twenty-four separate bones called vertebræ, which are very similar in shape. Each vertebra consists of a round portion called the *body*, and one or more projections called *processes*. These processes are in the rear, and are so arranged as to form a horizontal ring, with one projecting process called the "spinous process." All the rings and

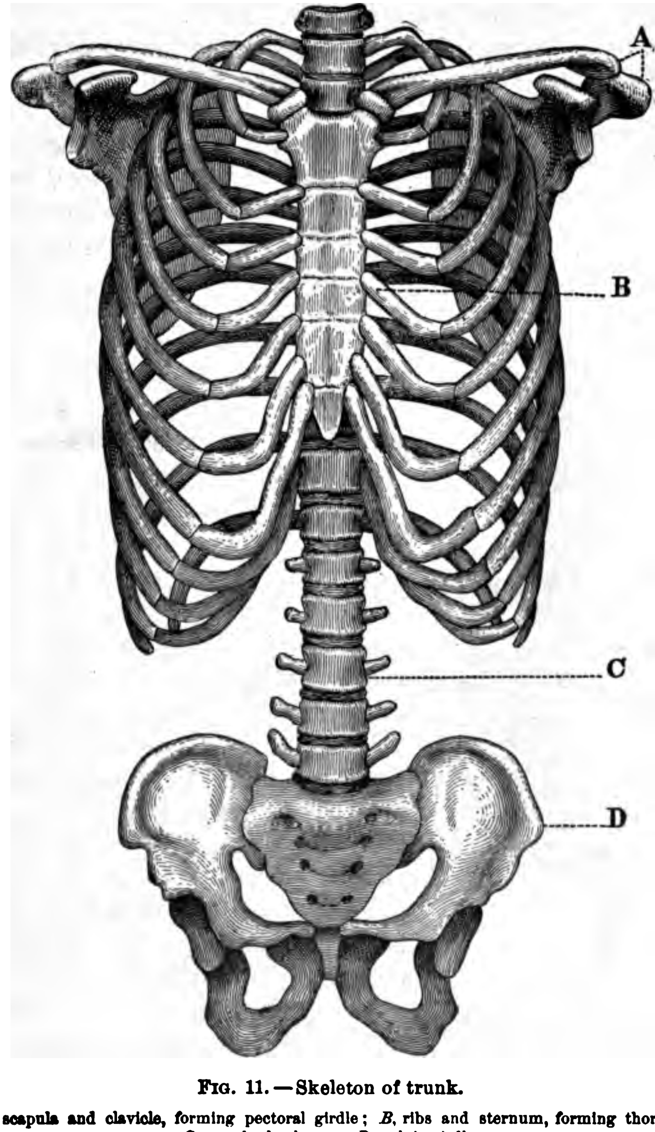


Fig. 11.—Skeleton of trunk.

A, scapula and clavicle, forming pectoral girdle; *B*, ribs and sternum, forming thorax; *C*, vertebral column; *D*, pelvic girdle.

their muscles form a sort of channel along the whole length of the spine, called the ***spinal canal***, which contains the spinal cord.

FIG. 12. — Vertebral column.

The bones of the spine are divided into the ***cervical***, ***dorsal***, and ***lumbar*** vertebræ. There are seven cervical vertebræ. The upper one is called the atlas, and articulates with the occipital bone. It takes its name from a heathen god who was thought to support the world upon his shoulders. The second cervical bone is called the axis; it has a pivot upon which the head turns. In bowing the head glides upon the atlas; in turning the head, the atlas turns upon its pivot, the axis. The remaining five cervical vertebræ do not have separate names; they have small bodies and small spinous processes. There are twelve dorsal vertebræ; their bodies are larger than those of the cervical vertebræ, and their spinous processes project outward and downward. There are five lumbar vertebræ; they have the largest bodies, and their spinous processes are nearly horizontal.

The *pelvis*, meaning the basin, consists of the *sacrum*, *coccyx*, and two hip bones, called *innominata* (nameless). The sacrum is a continuation of the spinal column, and is composed of five well-united parts, which were originally separate

vertebræ. The coccyx is a small extension of the spinal column, and composed of four united parts; the coccyx extended is the tail of some lower animals. The hip bones are expanded and irregular, and are firmly attached to the sacrum. Each contains a large cavity which receives the head of the thigh bone, thus forming the hip joint, the largest and strongest ball and socket joint in the body. The cavity of the pelvis contains a portion of the small intestines, and other vital organs.

6. The Bones of the Extremities. — The bones of the extremities are divided into the upper and the lower.

The upper extremities consist of sixty bones. The thirty bones of each arm are as follows: the *humerus* (one), the *radius* (one), the *ulna* (one), the *carpus* (wrist, eight), the *metacarpus* (five), and the *phalanges* (fourteen). The humerus is the bone of the upper arm: the radius and ulna are the bones of the forearm, the radius being on the side of the thumb, and the ulna on the side of the little finger; the ulna forms the elbow joint, while the radius, which is longest, forms the wrist joint, articulating with the carpal bones, and appearing to turn round the ulna in turning the hand. The bones of the wrist are arranged in two rows, thereby giving much greater strength and flexibility.

The *metacarpus* consists of five bones articulating with the carpal bones at one extremity and the bones of the fingers at the other. The *phalanges* are the bones of the fingers and thumb, each finger having three, and the thumb two.

The lower extremities have the same number of bones as the upper extremities. They are the *femur* or thigh bone (one), the *tibia* (one), the *fibula* (one), the *patella* (one), the *tarsus* (seven), the *metatarsus* (five), and

phalanges (fourteen). The femur is the longest bone in the body. The tibia, or shin bone, is the largest bone, and the fibula is the smallest bone in the leg. The fibula serves as a sort of brace to the tibia. The patella, or knee cap, is shaped like a chestnut, and lies over the joint formed by head of the femur and tibia in the knee; the ankle bones and the bones of the foot correspond to the bones of the hand, and the toe bones correspond to the bones of the same name in the hand, the great toe having two bones, and each remaining toe three bones.

7. The Os Hyoides. — The os hyoides, or hyoid bone, is located above the throat; this bone does not articulate with any other bone; it supports the tongue, affords attachment for many muscles of the throat, and is shaped like the letter U.

8. Sesamoid Bones. — Sesamoid bones were originally masses of cartilage, and are found in tendons where they pass over a joint or otherwise exert great pressure. The knee cap is the largest sesamoid bone in the body.

9. Wormian Bones. — These bones are found, sometimes, in the seams of the skull.

10. Joints. — In a general way there are two kinds of joints, called the ball and socket joint and the hinge joint. The former affords great freedom of motion, and the latter great strength. The hip joint and shoulder are examples of the ball and socket joint, and the knee and elbow are examples of the hinge joint.

The parts of a joint are the *bones*, *ligaments*, *cartilage*, *synovial membrane*, and *synovia*.

Ligaments in the form of cords or bands bind together the bones forming a joint; they may pass across the joint from one bone to the other, or surround the joint. Liga-

ments are tough, elastic, and contain but little blood; they are the injured parts in a sprain, which is a sudden

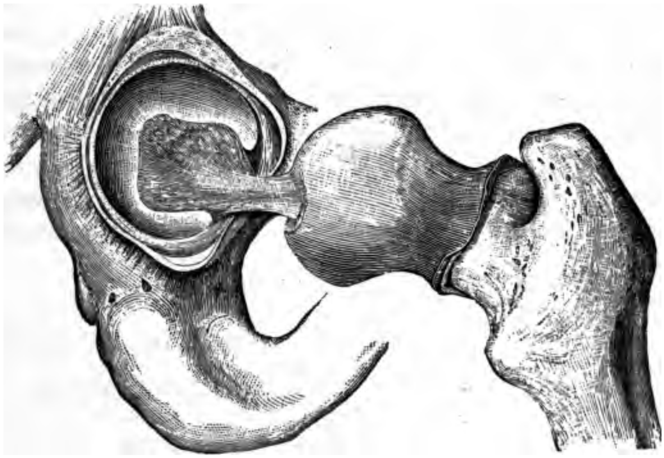


FIG. 13. — Ball and socket joint at hip.

wrenching or straining of the ligaments not sufficient to dislocate a joint, but often as serious as a dislocation.

Between the bones in movable joints there is a cushion of white, smooth, firm, elastic substance, called *cartilage*. It prevents rubbing of the bones in joints, and prevents or lessens shock in walking, jumping, or falling. Between the bones of the spine are cushions which enable the spine to bend, and protect the spinal cord and the brain. Cartilage is slightly compressible; long-continued pressure may change its shape for life, as in case of round shoulders. Flattening of spinal cartilage will slightly reduce one's height.

FIG. 14. — Hinge joint of the elbow.

1, humerus; 2, ulna.

Every joint in the body, like those of a machine, must be oiled. Inside of the ligaments, and covering the ends of the bones, there is a lining called the ***synovial membrane;*** it secretes a fluid called ***synovia***, which it pours out in the joints as needed. This fluid looks somewhat like the white of an egg, and is sometimes called joint water. If the synovial membrane is cut, the synovia runs out, leaving the joint dry and stiff until the cut heals and some new synovia is produced. If the injury is great, a scar may be left in the membrane and the joint made stiff for life.

OUTLINE SUMMARY

1. *Arrangement of Bones.* 1. Usually in pairs.
   2. Single bones — those in the median line of the body, the teeth, and the miscellaneous bones.
2. *How Named.* 1. Basis — shape, location, use, or appearance.
   2. Languages — Latin and Greek names are generally used.
3. *Divisions of the Skeleton.* 1. Names — head, trunk, extremities.
   2. Location — indicated by names.
4. *Bones of Head.* 1. Names — cranium, face, and ear.
   2. Number — there are twenty-eight of them. Name them.
5. *Trunk.* 1. Three groups — the thorax, spinal column, and pelvis.
   2. Names — make statement.
6. *Extremities.* 1. Number — one hundred and twenty bones.
   2. Names — make statement.
7. *Os Hyoides.* 1. Location — front part of the neck.
   2. Use — supports the tongue; attachment of muscles.
8. *Sesamoid.* 1. Location — usually, in tendons at a joint.
   2. Number — are not uniform in size or number.
9. *Wormian.* 1. Location — sometimes in the sutures of the skull.
   2. Use — to complete structure of skull.
10. *Joints.* 1. Kinds — hinge, and ball and socket.
    2. Parts — bones, ligaments, cartilage, synovial membrane, and synovia.

QUESTIONS

1. Why should there be so many bones in the cranium?
2. What are all the uses of bones?
3. What are the divisions and subdivisions of the skeleton?
4. What are the parts of a joint?
5. What are *tendons*, *ligaments*, *cartilage*, and *synovia?*
6. Describe the *Wormian*, *sesamoid*, and *hyoid* bone. What are *sutures?*

CHAPTER IV

WHAT BONES DO

1. **Motion.** — As already stated, the chief functions of the body are motion, nourishment, and control. Bones have an important use in making motion. They serve as a base for the attachment of muscles, and thus aid in movement of the parts of the body, or the body as a whole. If workmen wish to raise a heavy object, they may do it by means of a lever, and the bones may aid the muscles in a similar way.

2. **Framework.** — The framework of a house gives it shape and strength. The bones are the framework of the body — the solid parts around which softer parts are arranged, and within which delicate organs are placed. But for bones the body could not have its artistic shape or its great strength. The framework of the body differs from that of a house, as the parts of the body may be moved or folded.

3. **Protect Delicate Organs.** — As the shell of an egg protects the liquid parts, so the bones of the cranium protect the brain; the bones of the chest protect the lungs and heart, and those of the pelvis protect the delicate organs of the abdomen. The liver, brain, and eye are so delicate that they would easily be destroyed if it were not for the bones about them.

4. **Work of the Fingers and Toes.** — The bones of the fingers and toes are very similar, but have very different work; the fingers, with their tendons, are constructed for freedom of movement and great delicacy of touch, but toes for great strength and elasticity. The extent of the

work of the fingers is wonderful. The foot, too, has many uses. When a hand is lost, the foot can be trained to take the place of the hand in much important work. One without arms may be taught to write, paint, sew, handle tools, or even play upon a musical instrument, by use of the foot. Chinese mechanics are taught to pick up tools with their feet, while Arabs braid ropes with both fingers and toes.

5. **Products of Bones.** — Ground bone is a good fertilizer; phosphorus and other chemicals used in medicine and in the arts may be taken from bone. Animal charcoal, or boneblack, so useful in making shoe polish, in painting, and in refining sugar, is made from bone. Bone is used for handles, tools, buttons, and many other useful and ornamental articles.

6. **Nourishment.** — Bones have to be nourished like any other part of the body; they get their nourishment from the blood. Anything that affects digestion, or the circulation of the blood, will have its effect on the bones. The food of bones must be adapted to them both in quality and quantity. Alcoholic drinks and overeating disturb digestion, and thus affect the nourishment of the bone. A bad heart and bad nerves affect circulation, and prevent bones from getting proper food. Nourishing food, exercise, wholesome drinks, fresh air, sunshine, a dry atmosphere, and general cleanliness are necessary to keep bones healthy.

7. **Proportion of Parts.** — The parts of bone are grouped under the two heads, *earthy matter* and *organic matter*. The proportion of the parts differs (1) in different bones, (2) with the age of the person, and (3) in certain diseases. In the young, organic matter is in excess; in the aged, earthy matter is in excess; for this reason, old people are

more liable to fractures, and a broken bone unites more slowly.

Rickets is a disease in which the bones do not have enough earthy matter, and are not stiff enough to support the weight of the body. The bones bend, and become deformed. It can be cured.

8. Hygienic Measures. — Children should not be permitted to walk when very young, as the bones of the legs are not able to support the weight of the body, and bow-legs or other deformities may result. Children should not be lifted by the arms. Old persons should take great care to avoid falls, fractures, and dislocations.

Clothing should not be too tight; shoes too small and not shaped to the foot should not be worn. All unnatural positions that compress or misuse the bones should be avoided.

It is harmful to wear tight shoes, or shoes having sharp-pointed toes and high heels. Deformities follow all such practices. Even more harmful is the habit of tight lacing to make a beautiful waist. This causes the ribs to grow inward, and to compress internal organs so they cannot do their work. Many ills in later life can be traced to this cause. Both the bones and internal organs should be left free to get their full growth and strength. It is injurious to lean forward in sitting, to incline to one side, to keep one shoulder raised above the other, to sit too far down in a seat, or to sit with feet raised too high. Round shoulders are caused by careless habits. The bones of the head may be permanently deformed and the cranium injured by the way an infant is made to lie on its pillow, or lie with its head over the arm of its nurse. When bones are young and pliable, they will conform to any pressure placed upon them, and are frequently deformed for life, or ruined by thoughtlessness.

Two important rules should never be forgotten: (1) Keep the shoulders well up and back, and (2) keep the spine erect. Bending the body backward may be as injurious as bending it forward.

9. Dislocations. — A dislocation of bones is the displacement of the ends that make up a joint; a dislocation is usually due to accident or disease, and is known by deformity, pain, loss of motion, and loss of function. The bones must be put back in place and held there by splints, bandages, or other supports.

10. Fractures. — A fracture is a break in a bone. It is possible for any bone in the body to be broken, but fractures occur usually in the long bones and bones most exposed. Fractures are caused by violence and muscular contraction. They are known by deformity, pain, loss of function, and noise made by moving the parts. The broken parts must be put in place and bound together until they unite. Repair takes place by the formation of new bone in the break, and may take from two to twelve weeks.

11. Diseases. — Bones shrink from old age, disuse, and inflammation; bones enlarge because of too much blood, and increased use. Inflammation may set up in the periosteum, in the body of the bone, or in the marrow.

Tumors of bones frequently appear, and are sometimes called bone cancers. There is sometimes a softening of the bones due to the loss of lime.

12. Effects of Alcohol and Tobacco. — If the blood is poisoned, it will affect the bones. Tobacco and alcohol poison the blood and stunt the growth of bones. The cigarette habit, especially, prevents the bones from getting their required nourishment.

OUTLINE SUMMARY

1. *Motion*. 1. Work of bones — attachment of muscles, levers.
   2. Muscles — afford the power.
2. *Framework*. 1. How made — of bones.
   2. Movement — bones are movable, and may be folded.
3. *Protect Delicate Organs*. 1. Use — bones protect the brain, heart, lungs, liver, and the delicate organs within the pelvis.
4. *Work of Fingers and Toes*. 1. Structure — fingers for free movement and delicate touch, and toes for strength.
   2. The foot — trained to do almost all the work of the hand.
5. *Products*. 1. Chemical — fertilizer, phosphorus, and boneblack.
   2. Mechanical — handles, buttons, and ornaments.
6. *Nourishment*. 1. Sources — from the blood.
   2. How affected —bad digestion, circulation, food, and alcohol.
7. *Proportion of Parts*. 1. Matter — earthy and mineral.
   2. Changes — the proportion differing in different bones, in disease, and with age.
8. *Hygiene*. 1. Bowlegs — infants should not walk too soon.
   2. Pressure — tight clothing, and tight, ill-shaped shoes.
   3. Position — keep shoulders well up and back, and spine erect.
9. *Dislocations*. 1. Definition — displacement of bones at joints.
   2. Signs — deformity, pain, loss of motion, and loss of function.
   3. Treatment — the bones to be replaced and held by splints.
10. *Fractures*. 1. Signs — deformity, pain, loss of function, noise of parts.
    2. Treatment — to be set, held in place by splints or plaster.
11. *Diseases*. 1. General forms — bones subject to shrinkage and inflammation.
    2. Special forms — bone tumors and loss of lime.
12. *Alcohol and Tobacco*. 1. Alcohol — affects growth and strength.
    2. Tobacco — poisons blood, stunts bone.

QUESTIONS

1. What are the products of bone?
2. How do bones get their nourishment?
3. What is the cause of bowlegs?
4. What arguments can be made against tight clothing?
5. What are the differences between a dislocation and a fracture?
6. What are some of the leading bone diseases?
7. State the effects of alcohol and tobacco upon bones.

CHAPTER V

MUSCLES

1. Description. — The flesh of animals is called muscle; it clothes the skeleton, produces motion, and lines or completes cavities for the vital organs. There are in the body more than five hundred muscles, which make up about half its weight. Muscles are covered with a thin membrane, and are connected with bones, cartilages, ligaments, or skin, by small fibrous cords or bands called *tendons*. Muscles are found in the skin, the stomach, the intestines, the eye, the ear, the throat, and even in the brain. The diaphragm and the lungs are muscular, and the heart is a large muscle. Each muscle has a nerve supply from which it gets its power, and a blood supply which gives it nourishment and carries off its waste.

2. Appearance. — To the naked eye, uncooked muscle, or lean meat, appears to be a uniform mass; but when cooked thoroughly, a muscle falls to pieces in small strings, which are either bundles of muscular fibers, or flat, tapering bands. These bundles are composed of still smaller threads, called ultimate fibers, and covered with a very fine, delicate membrane. Muscles composed of fibers are called striped, while those composed of small bands, interlaced in every direction, are called unstriped muscles.

Under the microscope each fiber appears to be a transparent sheath inclosing a bundle of still smaller fibers called *fibrils*. Each fibril is made up of rows of cells, the smallest division of any living tissue.

3. Use. — The chief use of muscles is to make motion; this is done by contraction. Muscles contract by becoming

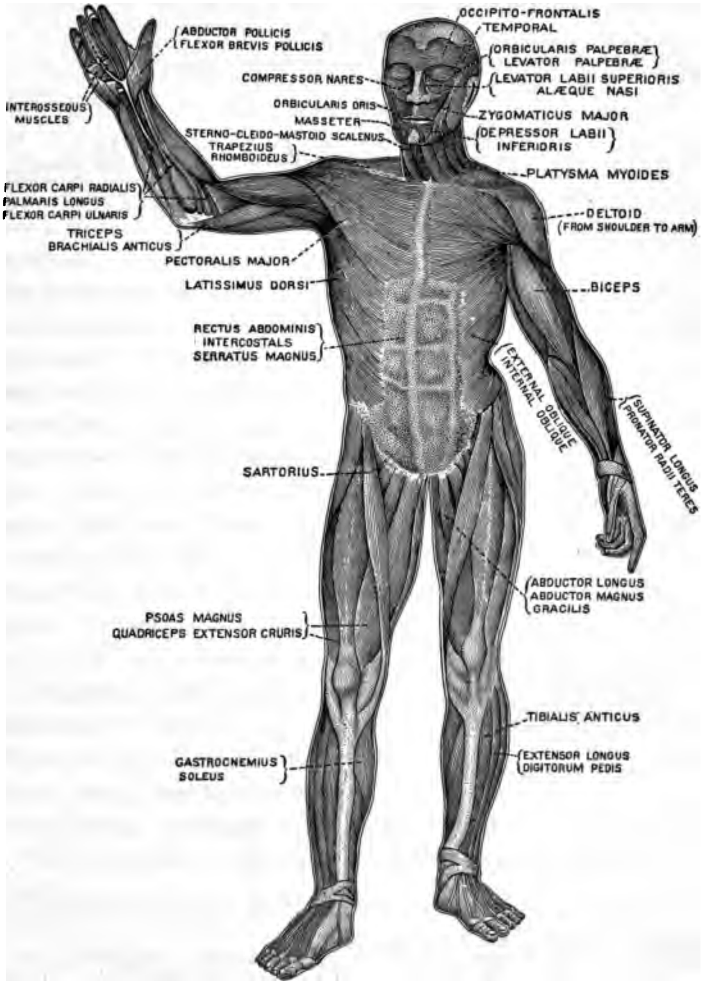


Fig. 15. — The muscular system.

shorter and thicker, and in this way move the parts to which they are attached; they have two main attachments; the first is called the origin, and the second the insertion. The movement of a muscle is toward the origin, while its force is exerted upon the point of insertion. We depend upon muscles for *language*, *music*, and all ordinary motion; also for expressions of joy, sorrow, anger, fear, and sickness.

4. Structure. — Muscles are large near the origin, or near the middle, and taper toward the insertion, sometimes becoming a tendon for crossing a joint. Striped muscles are composed of a large number of round parallel fibers bound into a bundle by a membrane; these bundles are bound into larger bundles, whose coverings thicken toward one or both ends to aid in forming tendons. In some striped muscles the fibrils are composed of small disks, which give the bundle transverse stripes. Muscular cells are the largest in the body, but cannot be seen with the unaided eye. The whole muscle is bound up in a sheath, or coat.

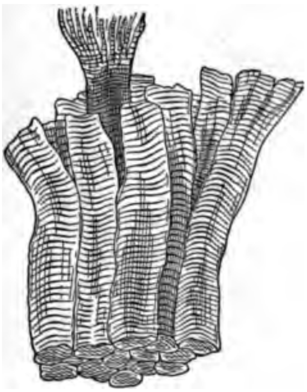


FIG. 16. — Muscle fibers.

5. Kinds. — Muscles are classified on several bases, as *action*, *position*, and *structure*.

As to action, muscles are (1) *flexors*, bending a joint; (2) *extensors*, straightening a joint; (3) *abductors*, moving a limb away from the body; (4) *adductors*, moving toward the body; (5) the *sphincters*, a sort of drawstring closing an opening, as the mouth.

As to position, muscles are (1) *superficial*, near the surface, or (2) *deep-seated*, near the bones.

As to structure, muscles are (1) *striped*, and (2) *unstriped*.

6. Action. — Voluntary muscles receive their orders from the will. The nerve of a muscle is sometimes injured so it cannot carry an impulse from the will, as in paralysis. Voluntary muscles are used in all the work of life, and are capable of much training.

Involuntary muscles are not under the control of the will. They receive orders from the spinal cord and other nerves without the aid of knowledge, or will. These muscles aid all the vital actions, as beating of the heart, digestion of food, and protection of the body. They never neglect their duty. If these muscles were voluntary, most of us would soon die from neglect, or forgetfulness. The cells of involuntary muscles have pointed ends; the cells are arranged in the form of thin leaves, and are usually placed around tubes whose action they direct.

7. Strength. — The strength of a muscle, when acting in obedience to the will, is wonderful. Muscles, when relaxed, are not very strong; they are easily torn, and offer but slight resistance to violence; but when commanded by a strong will, they are capable of exerting an enormous force, some men being able to lift many times their own weight.

8. Tendons. —Muscles taper into small, firm, strong fibrous cords or bands, called tendons. Muscles are usually attached to bones by means of tendons, but in some cases they are attached directly. Muscles are usually much larger than tendons, but sometimes exactly

FIG. 17.—Tendons of the hand.

the reverse is true, as in case of tendons of muscles that move the fingers. It is easy to locate the larger tendons of the body; tendons in the back or palm of the hand may be seen just under the skin, and tendons at the joints or in the neck may be found by the touch. The largest and longest tendon in the body is the one connecting the large muscles of the leg to the heel bone, and known as the tendon of Achilles. Tendons allow much greater freedom, and reduce bulk.

9. Names. — Muscles are named (1) from their form, as deltoid, like the Greek letter delta; (2) from location, as *tibialis;* (3) from their attachments, as *sterno-cleido-mastoidus;* (4) from their use, as flexors; and (5) from the number of attachments, as biceps and triceps.

OUTLINE SUMMARY

1. *Description.* 1. Muscles — flesh; clothe skeleton, make motion.
   2. Covering — a membrane, which forms tendons.
2. *Appearance.* 1. Under the microscope — either striped or uniform.
   2. Form — large in the body, and taper toward the ends.
3. *Use.* 1. Manner — produce motion by contraction; they make language, and help to express all emotion.
   2. Attachment — two points called origin and insertion.
4. *Structure.* 1. General — made up of small bundles of muscle, which are composed of smaller bundles, called ultimate fibers, each of which is composed of still smaller fibers, called fibrils, which are made up of cells.

2. The covering — thickens toward one or both ends, and sometimes forms tendons.
3. Cells — the largest of the body.

5. *Kinds.* 1. Bases — *action, position, volition,* and *structure.*
2. Action — extensors, abductors, adductors, and sphincters.
3. Position — superficial or deep-seated.
4. Structure — muscles are striped or unstriped.

6. *Action.* 1. Kinds — voluntary, involuntary, and mixed.
2. Ends — voluntary for skill, and involuntary for vital action.

7. *Strength.* 1. Natural strength — very great.

8. *Tendons.* 1. How formed — muscles taper into cords or bands.
2. Use — reduce bulk, give greater freedom.

9. *Names.* 1. Basis — *form, location, attachment,* and *use.*
2. Names of important muscles — make statement.

QUESTIONS

1. How do muscles appear to the naked eye? Under the microscope?
2. How do muscles contract? Origin, and insertion?
3. Describe the structure of muscles.
4. What are the kinds of muscles?
5. What is the difference between muscles and tendons?
6. How are muscles named? Give names of some important muscles.

CHAPTER VI

TRAINING OF MUSCLES

1. Care of Muscles. — To the health of muscles there are two essentials, namely, food and exercise. There are five kinds of food, — albumin, fat, sugar, water, and minerals; the last two of these pass through the body without much change; the other three are used in the work of the cells. Albumin rebuilds the cell as it wears out, and the other two are burned up in the cell to produce heat and energy for the body.

2. Oxidation. — Every one is familiar with the burning of fire; it is caused by oxygen in the air and carbon in the fuel; they come together in a way to produce oxidation, or

burning. A process almost like this goes on in the body. Oxygen enters the body when we breathe, finds its way to the cells, comes in contact with the food in the cells, and an actual burning takes place. Fat, sugar, and sometimes albumin, are burned. Oxidation produces *heat*, a gas called *carbon dioxide*, and water in form of vapor, called *vapor of water*, and leaves a mineral residue. All materials thus made are waste products, and must be removed by the blood. As the burning goes on, the cell itself is gradually burned, and is constantly renewed by a portion of the foods. To produce the necessary heat, to rebuild the cell, and to remove the waste materials, a good food and regular exercise are required.

3. **Exercise.** — To be healthy and strong, muscles must take up food regularly and well. In order to do this, they must be properly exercised every day. Muscles shrink, weaken, and lose their resistance, when not exercised; but when well exercised, they become firm, strong, and beautiful. Muscles cannot work constantly, as much time must be used in taking food. Not even the heart beats constantly; there is a brief period between beats, the heart really resting nearly half the time. A muscle may contract and expand without injury, but if it remains contracted very long, injury will ensue. Muscles are usually arranged in pairs, one contracting while the opposing muscle expands. Contraction of muscles is work, or exercise, while expansion, or relaxation, is rest. In all work, or exercise, one should try to bring about a pleasant change of movement, each muscle or set of muscles alternating with opposing muscles. All calisthenics should be based upon this principle.

4. **How Exercise produces Health.** — When one does not take exercise, the cells refuse to take up much

food, the unused food becomes a kind of waste matter, some of it even becoming poisonous. From some of this unoxidated food, *uric acid*, a dangerous poison, is produced; uric acid aids in bringing on rheumatism, some brain disorders, and other serious diseases.

When the muscles are exercised, there is more oxidation, and cells require more repair to meet these conditions; the blood must supply more food and oxygen; all this calls into greater action the heart, stomach, lungs, and brain; increased circulation removes waste matter with which the system is clogged, makes the cells feed faster, starts anew every vital process, and makes one feel better in every way. Unless the waste products are continually removed, the lungs are overworked, the action of the heart is obstructed, and the brain is clouded; the liver, stomach, and bowels refuse to work, derangement follows, and sickness begins. When the cells are properly fed, exercised, and relieved of waste material, it is almost impossible for one to become ill.

5. **How to Exercise.** — The occupation of many people affords sufficient exercise in both quantity and variety. Farmers, carpenters, bricklayers, millers, and workmen generally, find their chief difficulty in overwork, strain, or exhaustion of certain muscles to the neglect of others. Brain workers, desk workers, and all whose occupation requires much sitting, or standing in one position, or an exercise of one set of muscles, should arrange to take such exercise as will call into play all muscles not otherwise used. This should be done as regularly as they eat or sleep. Otherwise such persons cannot hope to have good health or long life. One should combine occupation and exercise as far as possible; something of agriculture, housework, and the manual arts generally should be

learned by every child. *Walking* is one of the best exercises. *Gymnasium exercises* are usually good, especially such as dumb-bell exercise, climbing, swinging clubs, and lifting weights; all exercises are better when taken in the open air. *Outdoor* games, if not too violent, are nearly all good; football and baseball are among the best, while tennis should be played in every school and in almost every family. *Carriage riding* affords little real exercise, but it is good for those whose work is very exhausting, and for delicate persons. *Horseback riding* is good because of the great variety of motion; it has, however, a passive element, and does not rank so high as the field sports.

When outdoor exercises are not convenient, some good indoor games, or exercises, should be had. Calisthenics for the class, and the various drills for individuals, can take the place of many field sports. The military drill is always good, either indoors or in the open air. Whenever indoor exercises are taken, doors and windows should be opened, and light, loose clothing worn.

Cycling, *fencing*, *rowing*, *dancing*, and *golfing*, when done with precision and in true spirit of sport, are invaluable. The various "health exercisers" for individual use indoors are good.

6. Rest. — The fact that the heart rests much of its time teaches a valuable lesson. We should sleep about one third of life; sleep should be perfect and abundant. Fatigue is nature's way of warning us that a muscle has been overworked. Rest is just as important as exercise. During rest, the tissues are renewed and fatigue overcome. Rest does not consist of suspension of work, so much as change. The best training of muscles consists in the proper alternation of exercise and rest. This principle explains the fact that it is easier to walk than to

stand. If we remain in one position, certain muscles are contracted, and become tired. It is important that both exercise and rest should be enjoyed. One of the essentials to health is happy, useful work.

7. **Violent Exercises.** — Violent exercise consists in sudden, powerful contraction of muscles. This results in strain, injury, or exhaustion. Fast running in games, jumping, lifting very heavy weights, jumping the rope, and violent football, tax the blood vessels to the utmost, and frequently result in rupture of an artery or paralysis of the heart. It is easy to overtax, especially if the contest is sharp, or players angry.

8. **Time for Exercise.** — "Exercise should follow rest," is a good rule. Upon this principle, the morning is the best time for exercise. The body is as hungry at this time for oxygen as it is for food. Good exercise and deep breathing are essential. Light exercise just before retiring is good for persons troubled with sleeplessness, as it distributes the blood. There should not be heavy exercise immediately before or after meals, as the stomach needs the energy of the body; no exhausting physical exercise should come just before or after heavy mental work. Five other good rules are: (1) exercise should come at that time of day when it is most enjoyable to the individual; (2) exercise is best at a time when we are least conscious of it, that is, when it is not a task; (3) every one should cultivate an interest in some subject of field, forest, or brook, and pursue it at that time which gives him most pleasure; (4) every one should have some skill in use of edged tools; and (5) games should arouse the mind and strengthen morals.

9. **Alcohol and Muscles.** — Alcohol prevents the digestive ferments from acting upon food, and thus deprives muscles

of their nourishment. Alcohol, by drawing water from the tissues, makes muscles shrivel and weaken. It hardens tissues, also, by coagulating their albumin. It is upon this principle that many animal and vegetable tissues are preserved in alcohol. Alcohol does not increase one's strength; it merely stimulates cells to use all their strength, instead of increasing it. In many cases of weakness or disease, alcohol is used as a medicine; it was once very generally used by physicians; but as medical science has advanced, many better remedies have been found, and whisky is now rarely used. Alcohol causes drunkenness, in which muscular action is disturbed. The brain loses its power over the muscles; a drunken man staggers, his voice changes, and frequently his eyes do not move together, so that objects appear double, or confused. The eyeballs sometimes roll, causing things to appear in a state of motion.

If alcohol is used, and for any length of time, its temporary results may become permanent; paralysis, indigestion, bad assimilation, shrinkage of muscles, reduced vitality, a bad heart and liver, gradual loss of intelligence and morals, and finally death, are the effects of the use of alcohol. Drink not only shortens life, but gives one a much smaller life, with vicious tendencies and low instincts all increased.

10. **Tobacco and Muscles.** — Tobacco is not a food, but a drug. It contains a dangerous poison. Whether chewed, smoked, or inhaled, it is injurious. It affects the nerves, producing a trembling of muscles, or palsy; it injures digestion and assimilation, the heart, the liver, and the brain. There is no condition of health or sickness where the use of tobacco gives an advantage. Cigarettes, even the best of them, are the most injurious form of to-

bacco, because the cigarette smoker usually inhales the smoke.

The tobacco habit should never be formed, but any one of good health and will can break the habit. The tobacco habit is only another form of the drug habit; and while it, like other drug habits, may be treated and overcome, it is best to cure it by discontinuing the use of tobacco.

11. Exercises for Muscles. — Exercise alone is not sufficient to make healthy muscles; they must have a good supply of pure blood; in order to get this, the digestive organs must be kept in good condition, the lungs must be given an abundance of pure air, the skin kept clean and healthy, and the body given good clothing and plenty of sunlight. The state of the mind is an important factor in muscular strength and skill, a cheerful, hopeful person being able to accomplish much more than one who is fretful and easily irritated.

The following exercises should be practiced regularly, each in its time and place, to get the best results : —

1. *Breathing.* 1. Long and deep — increase *volume* and *time;* keep time.
   2. Explosive — inhale slowly, and exhale forcibly.
   3. Modified — practice sighing, laughing, etc., in time.
   4. Lung exercises — arms extended in front, palms together, inhale as hands are separated and until they make a semicircle, and exhale until they are brought together again.
   5. Deep breathing with concave abdomen.
2. *Arm.* 1. Arms extended, in and out; up and down; on head, shoulders, and waist; then do each one *alternately*, in time.
   2. Striking — in time; up, down; forward, backward.
   3. Rowing exercises.
   4. Pulling candy exercise.
   5. Swinging bucket exercises, forward and backward.
   6. Flying exercise, in time.
3. *Shoulder.* 1. Front movement, both together, then alternate.
   2. Backward movement, both together, then alternate.

3. Perpendicular movement, both together, then alternate.

4. *Hand*. 1. Opening and closing exercises.
   2. Shaking exercise for circulation.

5. *Foot*. 1. Ankle movements, in and out, up and down.
   2. Shaking exercises for circulation.
   3. Lifting exercises — lifting, pushing, pulling.

6. *Head*. 1. Lateral — left and right.
   2. Bowing — forward, backward.
   3. Rotary — left, right.

7. *Eye*. 1. Lateral — right, left.
   2. Perpendicular — up, down.
   3. Rotary — with the hands of the clock, then reverse.

8. *Leg*. 1. Marching — forward, backward, oblique, lock step, and marking time.
   2. Raising and lowering body — right position, then the left.
   3. Kicking exercises — forward, backward, lateral.

9. *Waist*. 1. Lateral — hands on hips; right, left, forward, backward; hands over head, same; concave abdomen, same.
   2. Forward — back straight, bending only at hips; touch floor with tips of fingers; then raise and lower body, resting on hands and feet, with legs and arms straight.

10. *Manual of Arms* — Use wooden guns, or broomsticks, and take the forms slowly.

11. *Dance* — select simple figures, practice intelligently, and try to master one figure before beginning another.

OUTLINE SUMMARY

1. *Care of Muscles*. 1. Food and exercise — required by muscles.
   2. The kinds of foods — albumin, sugar, fat, water, and minerals.

2. *Oxidation*. 1. Elements — sugar and fat, sometimes albumin, oxidize to produce the heat of the body, and energy.
   2. Wastes — oxidation produces heat, carbon dioxide, water, and a mineral residue.
   3. Place — goes on in every cell in the body.

3. *Exercise*. 1. Effects — causes cells to take up food.
   2. Elimination — removes waste materials from the cells.

4. *How Exercise produces Health*. 1. Assimilation — causes cells to take up more food.
   2. Oxidation — causes increased oxidation.

5. *How to Exercise*. 1. Good exercise — gives every muscle something to do. Alternate.
   2. Games — exercise should include some outdoor games.

3. Mild forms — carriage riding gives little exercise; horseback riding is better. Many indoor games are good.
4. Other forms — cycling, fencing, rowing, dancing, and golfing.

6. *Rest.* 1. Rest — essential to good health.
2. Form — rest comes from a change of work, not suspension.
3. Manner — some rest should be taken each day.

7. *Violent Exercises.* 1. Effects — hard exercises exhaust the cells.
2. Danger — spirited games sometimes rupture blood vessels, or paralyze the heart.

8. *Time for Exercise.* 1. Order — should follow rest.
2. Relative time — should not come just before or after meals.
3. Rules — five good rules of exercise.

9. *Alcohol and Muscles.* 1. Nourishment — prevents digestion; muscles do not get nourishment.
2. Affinity for water — draws water from the muscles; shrink.
3. Strength — does not make strength, but makes tired muscles work harder.
4. Muscular action — destroys muscular action, and its effects may become permanent.

10. *Tobacco and Muscles.* 1. Effects — poisons the muscles directly and indirectly.
2. Cure — discontinue gradually.

11. *Exercises for Muscles.* 1. Necessities — name other things needed.
2. Forms — list of exercises.

QUESTIONS

1. What is the effect of *exercise* and *rest* upon muscles?
2. What is oxidation? What elements burn?
3. How should one take exercise?
4. What is the best time for exercise?
5. What are the effects of alcohol and of tobacco on muscles?

CHAPTER VII

THE DIGESTIVE SYSTEM — MOUTH

1. Organs. — The organs of the digestive system are the alimentary canal and accessory organs. The alimentary canal is a tube about thirty feet long, extending throughout the trunk, and lined with mucous membrane. Its parts are the *mouth*, *pharynx*, *esophagus*, *stomach*, and

intestines. The accessory organs are the ***teeth***, ***salivary glands***, ***liver***, ***pancreas***, and ***spleen***.

Digestion takes place in almost the entire alimentary canal, but the chief places of digestion are the mouth, the stomach, and the intestines.

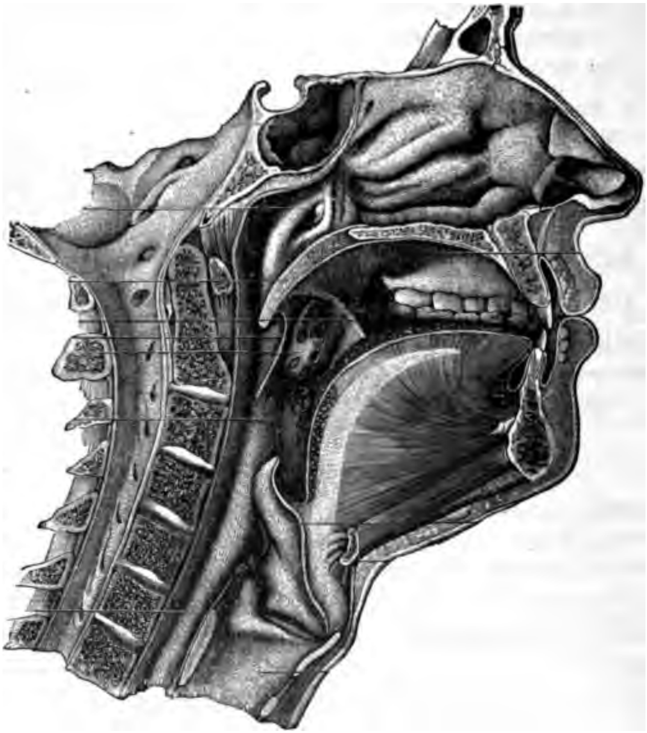


FIG. 18.—Vertical section of the head and neck.

2. Mouth.—The mouth is the organ of chewing or mastication. The mouth is also one of the principal organs of voice. The tongue rests on the base of the mouth, forming the greater part of the floor. The roof is composed of parts of the superior maxillary and palate bones,

lined by the hard palate. The lips are the front, and the cheeks the sides of the mouth. The back part of the mouth is connected with the pharynx. From the top of the opening at the back part of the mouth hangs the uvula, a curtain sometimes called the hanging palate; on either side of the uvula are the two glands called tonsils. The lips and cheeks outside, and the tongue inside, hold the food between the teeth in chewing. The inside of the mouth is lined with mucous membrane. The mouth is aided by two of the accessory organs, the teeth and salivary glands.

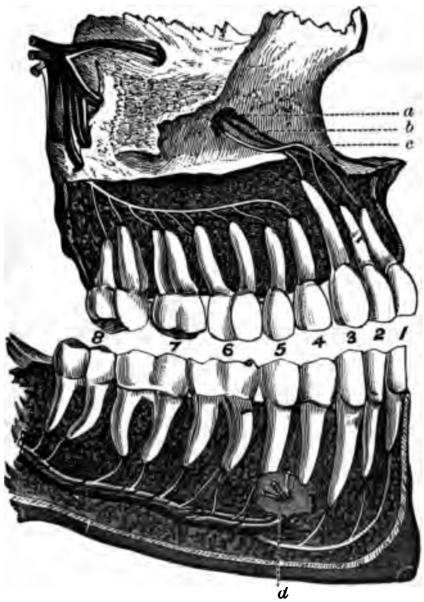


Fig. 19.—The jaws and the teeth.

1, 2, incisors; 3, canine; 4, 5, bicuspids; 6, 7, 8, molars; *a*, vein; *b*, artery; *c*, nerve; *d*, vein, artery, and nerve. [From Johonnot and Bouton.]

3. The Teeth.—There are two sets of teeth; the first set is called *temporary*, or *milk teeth*, and the second set is called *permanent* teeth. There are twenty temporary, and thirty-two permanent teeth.

The temporary teeth begin to appear when the child is six or seven months old; the first to appear, usually, are the two front teeth in the lower jaw; in a short time, two to match appear in the upper jaw; a little later one appears on each side of the central ones in both jaws; in the same manner teeth continue to appear until about the end

of the third year, when the temporary set is complete with ten teeth above and ten below; this ends the period of first dentition. The temporary teeth remain until about the close of the sixth year, when they begin to come out, and the permanent teeth take their places. When the permanent teeth begin to grow, they disturb the roots of the temporary teeth, causing them to decay, the blood absorbing the waste material; as the roots of the teeth are absorbed, they get loose and come out. When a temporary tooth becomes loose, it should be pulled out so the new tooth can grow out straight.

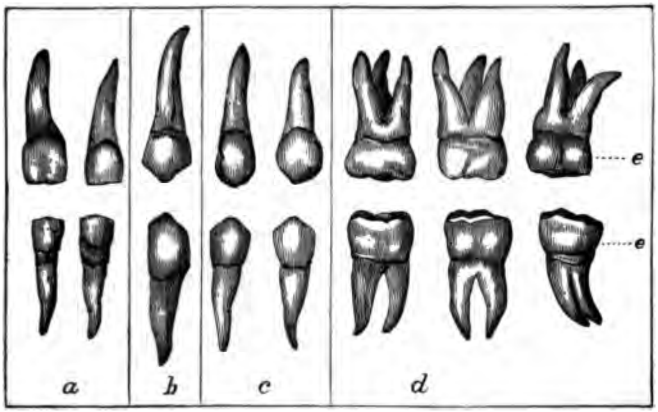


FIG. 20.—Teeth.

a, incisors; *b*, canine; *c*, bicuspids; *d*, molars.

There are sixteen permanent teeth in each jaw. Each tooth is firmly set in a cavity or socket in the jawbone, as a post is set in the ground, and is supplied with a nerve and blood vessels. Teeth differ in shape and position according to the work they are to do. In each jaw the four front teeth are called *incisors;* they are broad, thin, and sharp, and used for cutting or biting off bits of food. The next one on each side is called *canine*, is larger than

the others, pointed, very strong, and used for holding and tearing food. These teeth in some of the lower animals are called tusks, and in some wild animals are large and dangerous. Next to the canines are the *bicuspids*, two on each side; they are so named because they have two fangs, or points, and are used for tearing, cutting, and grinding. The last three on each side, above and below, are called *molars*, and are used for grinding or crushing the larger and coarser articles of food; they are large, strong, short and thick, situated near the hinge of the jaw where there is greatest power, and are very firmly set in the jawbones; the upper ones have five points, and the lower ones have four. The last molars, one on each side, above and below, are called wisdom teeth, and develop very slowly, appearing usually from the seventeenth to the twenty-first year.

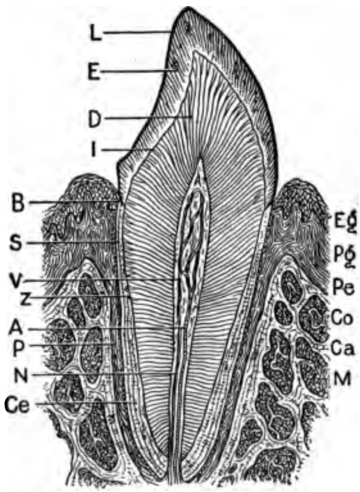


FIG. 21.—Diagram of the structure and setting of a normal incisor tooth. [Bödecker.]

L, cuticle of enamel; *E*, enamel; *D*, dentine with canaliculi; *I*, layer between enamel and dentine; *B*, border line between enamel and cementum of neck; *S*, cementum of neck; *Ce*, cementum of root; *Z*, layer between dentine and cementum; *P*, pericementum; *A*, arteriole of pulp, branching into capillaries; *V*, vein of pulp taking up capillaries; *N*, medullated nerve fibers of pulp; *Eg*, epithelium of gum; *Pe*, periosteum; *Ca*, bone tissue of alveolus; *Pg*, papillary layer of gum; *Co*, cortical bone of alveolus or socket; *M*, spaces of bone.

Every tooth has three parts, *crown*, *root*, and *neck*. The crown is the top, the root is the part resting in the socket of the jawbone, and the neck, which is usually smaller, is the part that connects the crown and root, and is covered

by the gums. All the teeth except the molars have one root; the upper molars have three and the lower ones two.

In structure, the body of the teeth is composed of a white, bonelike substance, called dentine, which is much harder than ordinary bone; the body contains a cavity filled with a soft substance called pulp; it contains the nerve which gives the tooth feeling, and blood vessels which supply it with nourishment. The root of the tooth is covered with a substance called cement, and the crown is covered with a substance called enamel. This is the hardest substance in the body, is very durable, and gives beauty and protection to the tooth.

Teeth not only cut and grind food, but help to make articulate sounds. In the case of many lower animals teeth are used in defense, and in securing food. Clean, healthy, well-shaped teeth are prominent features of a fine face.

4. The Tongue. — The tongue is a muscular organ, covered with mucous membrane. The upper surface contains a multitude of small projections called papillæ, which contain the nerve ends of the tongue and render this organ very sensitive to taste, to temperature, and to both the location and condition of particles of food. From above, the tongue appears to be a muscle about two inches wide and four to six inches long. From the side it looks to be fan-shaped, with the hinge of a fan in the base and back part of the mouth. It is used to test foods by their taste, to hold food between the teeth, and to push it backward in the act of swallowing. It is also a leading organ in the production of voice.

5. The Salivary Glands. — A gland is a sort of cavity, or reservoir, the chief function of which is to gather a fluid, hold it for use, and discharge it when needed. Glands vary in shape according to their use, contents,

and location, some being very irregular, others uniform. A gland may be a tube, or a collection of tubes, emptying into a common vessel having one or many tubes as discharge pipes which open the surface where the fluid is to be used. The fluids are secreted or gathered from the blood. The alimentary canal is supplied with various glands, the first of which are the salivary glands, which secrete a fluid called saliva, and empty in the mouth. There are three pairs of the salivary glands, known as the *parotid*, the *submaxillary*, and the *sublingual*. The parotid, which is the largest, is situated in front of the ear and near the skin, and discharges into the back of the mouth. The submaxillary, the second in size, is located below the angle of the lower jaw, and discharges upon the floor of the mouth. The sublingual is the smallest; it is located beneath the tongue, and discharges in the floor of the mouth near the lower front teeth. The salivary glands are composed of many parts, or lobes, which are composed of several smaller lobules, all grouped something like a bunch of grapes. All lobules, or bags, have tubes to unite into the larger ones empty-

FIG. 22.—Salivary glands.

ing into the duct of the gland. Saliva is a clear fluid of alkaline reaction, and consists mostly of water. Its chief work is to dissolve the food and to change starch into sugar.

OUTLINE SUMMARY

1. *Organs.* 1. Alimentary canal — mouth, pharynx, esophagus, stomach, and intestines.
   2. Accessory organs — teeth, salivary glands, liver, pancreas, and spleen.
2. *Mouth.* 1. Uses — organ of mastication, and voice.
   2. Parts — base, floor, roof, sides, front, and back.
   3. Organs — make statement of organs making up the parts of the mouth.
3. *Teeth.* 1. Sets — two, temporary and permanent.
   2. Temporary — name and describe them.
   3. Permanent — name and describe them.
   4. Parts — crown, root, and neck.
   5. Structure — dentine, pulp, cement, and enamel.
4. *Tongue.* 1. Description — muscular; mucous membrane; papillæ.
   2. Shape — a fan-shaped muscle with hinge of fan at back.
   3. Use — aids in mastication, swallowing, and making voice.
5. *Salivary Glands.* 1. Three pairs — *parotid*, *submaxillary*, and *sublingual*.
   2. Location — in front of ear, under tongue and jaw.
   3. Secretion — saliva, containing a ferment which changes starch to sugar.

QUESTIONS

1. What are the parts of the alimentary canal? What are the organs?
2. What organs compose the mouth?
3. What are the *sets*, and *parts* of the teeth?
4. What are the *uses*, and *structure* of the tongue?
5. Describe the salivary glands. What is saliva?

CHAPTER VIII

THE DIGESTIVE SYSTEM — STOMACH

1. Pharynx. — On the way from the mouth to the stomach there are two organs, namely, the *pharynx* and the *esophagus*. The *pharynx* is between the mouth and esophagus. It is a sort of vestibule, or hallway, having

seven openings, by which it connects with the mouth and the esophagus, the larynx, the nose, and the ears through Eustachian tubes.

The two openings into the nose and the ears may be closed by raising the back part of the roof of the mouth; the opening into the larynx may be closed by means of a little drop curtain called the *epiglottis*, and the opening with the mouth may be closed by curtains. In the act of swallowing this is done, the muscles of the pharynx forcing the food into the open mouth of the esophagus.

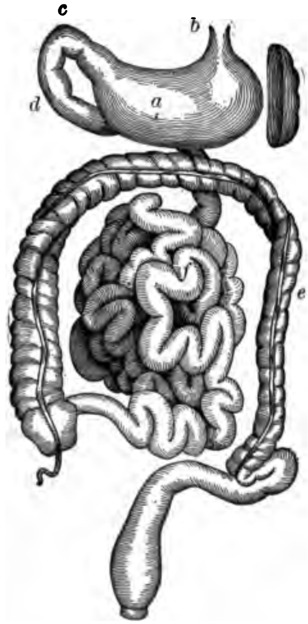


FIG. 23.—Stomach and intestines.

a, stomach; *b*, cardiac orifice; *c*, pylorus; *d*, duodenum; *e*, large intestine; *f*, small intestine.

2. The Esophagus. — The esophagus is a tube about nine inches long; it lies behind the trachea, heart, and lungs, and leads from the pharynx to the stomach. The esophagus has three coats, the internal being a mucous membrane, the middle, cellular, and the external, muscular. The muscular coat is composed of two sets of fibers, the outer one running lengthwise the tube, and the inner running around the tube, forming a series of muscular rings. After the food passes into the pharynx, it is beyond control. Both the pharynx and esophagus excrete or throw out mucus, which keeps the walls moist, and aids in the passage of food.

3. Location of Stomach. — In studying bones we learned that the trunk contains two large cavities; the upper one, called the thoracic cavity, contains the *lungs* and *heart;* the lower one, called the abdominal cavity, contains the *stomach*, *intestines*, *liver*, and *kidneys*. These cavities are separated by the diaphragm, a muscular curtain extending across the trunk.

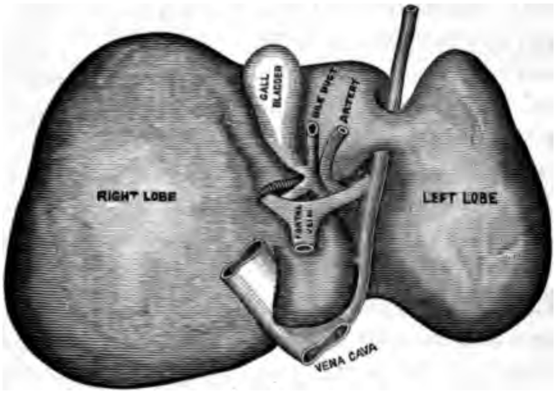


FIG. 24. — The liver.

The stomach is located just below the diaphragm, the greater portion lying to the left of the median line of the body, and just under the lowest ribs.

4. Dimensions. — The stomach, which is an expansion of the esophagus, is a thin bag of muscular walls, pear-shaped, about twelve inches long, four inches broad, and three inches thick; an average stomach, when filled, will hold about three pints; its walls can be stretched until it will hold almost twice as much as when in a natural state. If often filled too full, it becomes permanently enlarged, and injured. The stomach does not swing in a horizontal line, but descends toward the right side; it

is not of uniform size, the left end being the larger, and tapering somewhat toward the right.

5. **Openings.** — At the point of union between the esophagus and stomach there is an opening called the *cardiac orifice;* it is a kind of muscular ring; at the opposite end, where the food leaves the stomach, is the *pyloric orifice*, which has a sort of valve called the *pylorus*, formed of a fold of the mucous membrane. The word "pylorus" signifies "gate keeper." Food not ready to pass from the stomach is sent back, the valve refusing to open.

6. **Structure.** — The esophagus does not enter the stomach at the end, but on top near the end; that part of the stomach beyond the cardiac orifice to the left is called the splenic end; the smaller portion of the stomach to the right of the cardiac orifice is called the pyloric extremity.

The walls of the stomach have four coats. The inner coat is a mucous membrane; the next is a *cellular* coat; the third is a *muscular* coat whose fibers run lengthwise, crosswise, and obliquely, affording motion in three directions; the fourth and last coat is serous. The mucous lining does not fit closely, but lies in many valley-like depressions which increase the mucous surface. Under the microscope the mucous lining looks something like honeycomb, there being many little depressions, in the bottom of which may be seen openings of the tubes of gastric glands, which secrete gastric juice, the chief agent of stomach digestion.

7. **Gastric Secretions.** — The greater part of gastric juice is water; it contains also hydrochloric acid and pepsin; it is a clear, watery fluid, and has the power of dissolving albumin and changing it into *albuminose*, or peptone. When food enters a hungry, healthy stomach, gastric juice

begins to flow from hundreds of glands, very much as saliva flows into the mouth; the food is soon dissolved, part of it being changed into a new substance called chyme. Gastric juice has no effect on sugar and starch,

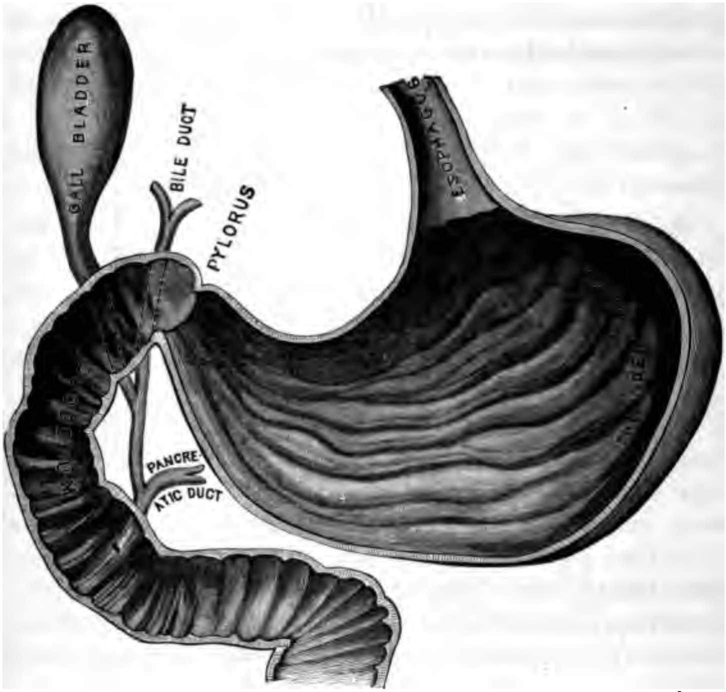


Fig. 25.—Stomach and duodenum.

The anterior walls are cut away to show the folds of the mucous membrane, rugæ of stomach, and valvulæ conniventes of intestine.

nor on fats and oils; these undergo proper change when they come into other digesting fluids. The amount of gastric juice secreted in a day is about three quarts.

8. **Motion.**—The stomach has a peculiar motion called peristalsis; it is a sort of churning process, by which all

particles of food are dissolved and mixed with gastric juice. It begins as soon as food enters the stomach, and continues until stomach digestion is finished; then the pyloric end of the stomach contracts, and forces the digested food through the pyloric orifice; if there are undigested particles, a movement is set up in the opposite direction, and they are thrown back to be churned again and prepared for another movement toward the pylorus.

OUTLINE SUMMARY

1. *Pharynx.* 1. Location — between mouth and esophagus.
   2. Openings — seven, nose, mouth, esophagus, ears, and larynx.
2. *Esophagus.* 1. Location — between pharynx and stomach; behind trachea, heart, and lungs.
   2. Coats — three, internal mucous, cellular, and external muscular.
   3. Structure — a series of muscular rings.
3. *Location of Stomach.* 1. Cavities — thoracic and abdominal; contents.
   2. Point — in abdominal cavity, just below diaphragm, a little to left, and beneath lowest ribs.
4. *Dimensions.* 1. Shape — pear-shaped; tapers toward the right.
   2. Capacity — about three pints, but may hold twice as much.
5. *Openings.* 1. Cardiac orifice — muscular ring where the food enters.
   2. Pyloric orifice — a valve, where food leaves the stomach.
6. *Structure.* 1. Divisions — splenic end, and pyloric extremity.
   2. Coats — four, a mucous, vascular, muscular with three sets of fibers, and serous; mucous coat lies in ridges and valleys.
   3. Glands — mucous glands and gastric glands.
   4. Alveoli — depressions containing opening of tubes from gastric follicles.
7. *Gastric Secretions.* 1. Gastric juice — converts albumin into peptones.
   2. Hydrochloric acid — an important agent in digestion.
   3. Pepsin — a ferment which aids in changing albumin to peptone.
8. *Motion.* 1. Direct — peristalsis, a wavy, churning motion.
   2. Reverse — a movement from the pylorus, for undigested food.

QUESTIONS

1. How many openings has the pharynx?
2. Describe structure and motion of esophagus.
3. Give *location* and *size* of the stomach.

4. Describe the openings of the stomach. What is the structure of the stomach?
5. What is gastric juice? Of what is it composed?
6. Describe the motion of the stomach. What is the motion called?

CHAPTER IX

THE DIGESTIVE SYSTEM — INTESTINES

1. Divisions. — The intestines are divided into the ***small intestines*** and the ***large intestines;*** the parts of the former are the ***duodenum, jejunum,*** and ***ileum;*** the small intestines are about twenty feet long; the parts of the large intestines are ***cæcum, colon,*** and ***rectum;*** these are about five feet in length.

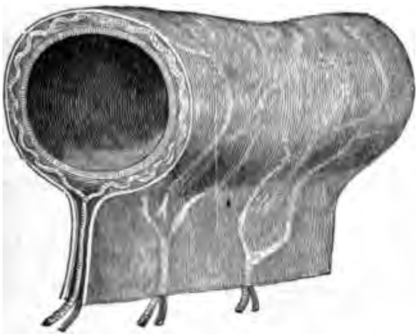


FIG. 26. — Diagram representing a cross section of the small intestine, showing the three layers, and the way in which the blood vessels pass between the two folds of serous membrane (the peritoneum).

2. Structure. — There is but little difference in the walls of the small and large intestines. The walls of the small intestines have four coats, the inner being a mucous coat, the second muscular, the third cellular, and the outer serous. The mucous coat contains many folds, or wrinkles, which greatly increase the surface. The entire surface of the small intestines is covered with small projections called *villi.* Each villus contains a vein, an artery, and a lacteal. The large intestines have folds similar to those in the small intestines, but no villi. The mucous surface contains glands that secrete a fluid known as intestinal juice.

3. The Duodenum. — This is the first division of the small intestines; it is from eight to ten inches long, and is sometimes called the second stomach. The duodenum extends upward, backward, and to the right from the pylorus, then descends, and crossing the spinal column,

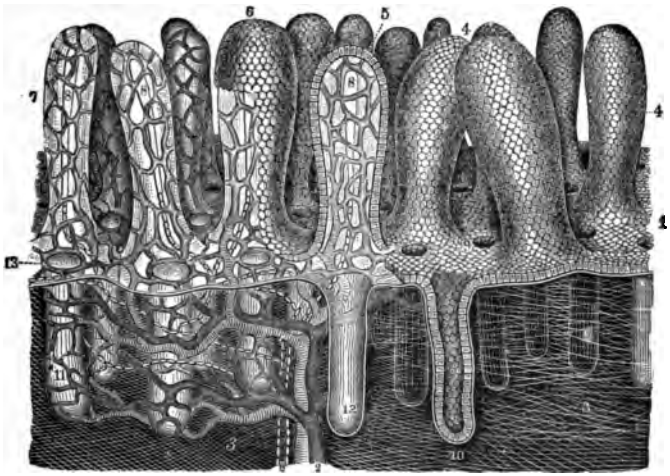


FIG. 27. — The mucous membrane of the ileum, highly magnified.

1, cellular structure of the epithelium, or outer layer; 2, a vein; 3, fibrous layer; 4, villi covered with epithelium; 5, a villus in section, showing its lining of epithelium, with its blood vessels and lymphatics; 6, a villus partially uncovered; 7, a villus stripped of its epithelium; 8, lymphatics or lacteals; 9, orifices of the glands opening between the villi; 10, 11, 12, glands; 13, capillaries surrounding the orifices of the gland.

unites with the jejunum. The duodenum receives food at the pylorus, bile from the liver, and pancreatic juice from the pancreas.

4. Ileum. — The ileum is smaller than the jejunum, is about twelve feet long, and lies in folds and coils. This division completes the small intestines, and with its companion, the jejunum, occupies the central part of the abdominal cavity and lies within the coil of the large intestines.

5. Cæcum.—The large intestine is not an enlargement of the small intestine, but a separate tube, differing in structure and size. The end of the large intestine is closed and the small intestinal tube enters it about three inches from the closed end. The cæcum is that part of the large intestine from the closed end to the point where the small intestine enters. Projecting from the closed end of the cæcum is the ***vermiform appendix.***

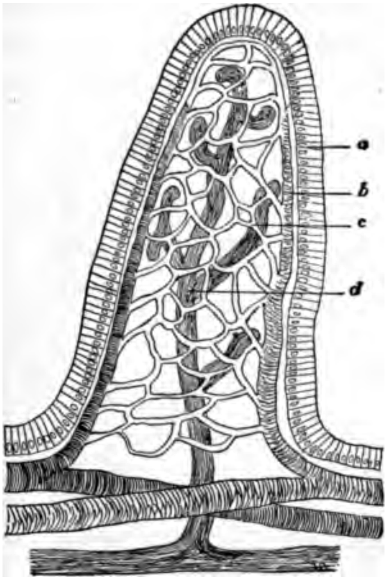


FIG. 28.—Diagram of the essential parts of a villus.

a, epithelium which takes up food and transports it to the tubes within; *b*, an artery; *c*, capillaries; *d*, a lacteal.

FIG. 29.—**Structure of glands.**

1, simple pit, surrounded by capillaries; 2, flask-shaped gland, with short duct; 3, 4, more complex glands, with longer ducts.

6. Colon.—The colon almost surrounds the small intestines; it ascends on the right side, crosses the body just below the stomach, and descends on the left side. The parts are (1) the *ascending colon*, (2) the *transverse colon*, and (3) the *descending colon.* The colon has two cords on opposite sides running almost the entire length.

7. Vermiform Appendix.—The appendix takes its rise near the closed end of the cæcum; it is a tube about the size of a goose quill and from three to six inches long. Its use is not well known. It is the seat of a very dangerous disease called *appendicitis*, which is usually cured by a surgical operation. It is not true, as sometimes believed, that this disease is caused by cherry stones, grape seeds, and other small seeds, but it may be made worse by them.

OUTLINE SUMMARY

1. *Divisions.* 1. Small intestines—duodenum, jejunum, and ileum.
   2. Large intestines—cæcum, colon, and rectum.
2. *Structure.* 1. Coats—four, mucous, muscular, cellular, and serous.
   2. Folds—mucous coat contains many ridges and valleys.
   3. Villi—projections; each has a vein, an artery, and a nerve.
3. *Duodenum.* 1. Location—between stomach and jejunum.
   2. Shape—a tube, extending upward, backward, and to the right from pylorus, then turns toward left and crosses abdomen.
   3. Work—receives pancreatic juice and bile; practically completes digestion.
4. *Jejunum and Ileum.* 1. Jejunum—follows duodenum, and is about eight feet long.
   2. Ileum—follows jejunum, and is about eleven feet long.
   3. Form—both lie in folds and coils.
5. *Cæcum.* 1. Form—the closed end of a tube.
   2. Size—about three inches in length.
   3. Projection—the vermiform appendix.
6. *Colon.* 1. Location—almost surrounds small intestines.
   2. Parts—three sides and three flexures.
   3. Structure—a large tube, with two longitudinal cords.
7. *Vermiform Appendix.* 1. Location—projects from closed end of cæcum.
   2. Size—as large as a goose quill, and three to six inches long.
   3. Disease—appendicitis, cured by removal of appendix.

QUESTIONS

1. What are the divisions of the intestines?
2. What is the structure of the intestines? Describe villi.
3. How long are the small intestines?
4. Describe the colon.
5. What is the vermiform appendix? Why so called, and to what disease is it subject?

CHAPTER X

THE DIGESTIVE SYSTEM — ACCESSORY ORGANS

1. Organs. — The accessory organs are the teeth, salivary glands, liver, pancreas, and spleen. The accessory organs aid digestion, either by their work or secretions. The teeth are the chief organs of mastication, while all the other accessory organs aid by their secretions, or action upon the blood. The teeth and salivary glands have been described in Chapter VII.

A gland either gathers or makes a fluid; it is either a simple tube, a combination of tubes, or a reservoir with its tubes; in each case the tubes and reservoir are lined with cells that are the chief agents in producing the fluid. Mucous glands are of the simpler forms, while the liver and the kidney are examples of the more complicated forms.

2. The Liver.—The liver, which is the largest gland of the body, is located in the right side just beneath the diaphragm; it is about ten inches from side to side, six or seven inches from front to back, two to three inches thick, and weighs about four pounds. The liver has five *ligaments*, five *lobes*, five *fissures*, and five *vessels*. The ligaments are folds of the covering; the lobes are the large divisions of the liver; the fissures are deep furrows between the lobes on the under side; and the vessels carry fluids to or from the liver. The liver is of a reddish brown color, and secretes a greenish yellow fluid called bile, which, for good health, is one of the most important fluids of the body. (See Fig. 24.)

In structure, the liver appears to the naked eye as a muscular, semisolid body, more or less filled with tubes,

that vary in size, subdivide, diminish, and terminate in small masses of cells called lobules, each of which has a vein, artery, and nerve. The vessels of the liver, five in number, are (1) the *portal vein*, (2) *hepatic artery*, (3) *hepatic veins*, (4) *hepatic duct*, and (5) the *lymphatics*. The branches of the portal vein come from the stomach, spleen, and intestines. The vein subdivides until it reaches every lobule of the liver. It brings in bad blood which undergoes certain changes in the lobules, and is taken up by the hepatic vein and carried back into the general circulation. This is called the *portal circulation*. The hepatic artery supplies the liver with good blood. The hepatic duct is made up of many small branches that begin in the lobules. It carries bile to the duodenum.

3. Bile. — Bile is produced in the lobules of the liver. It is really a waste product, but aids pancreatic juice in intestinal digestion. About a quart of this fluid is secreted daily. The liver has an arrangement for storing up surplus bile; on the under side of the liver is a bag, called the *gall bladder*, in which bile is stored for use as needed.

4. Glycogen. — Besides secreting bile, the liver makes glycogen, sometimes called animal starch. Saliva and pancreatic juice convert starch into sugar, which is easily absorbed. Starch cannot be absorbed. In a short time after each meal sugar would be thrown into the general circulation, and there would be a very large amount in the blood. This is regulated by the liver. Sugar is taken up by the portal vein, and carried to the liver, where it is converted into glycogen, or starch, which is stored in the liver. When needed, it is converted into sugar again, and turned over to the general circulation. In this way it is given to the system gradually; otherwise, immediately

after meals, the system would have too much sugar, and before another meal it would be without sugar entirely.

5. Pancreas.—The pancreas is a gland, and lies behind the stomach. It is the same as the sweetbread in the hog; in shape it is somewhat like a dog's tongue. The pancreas secretes the pancreatic fluid, which passes into the duodenum. This fluid is one of the most important in the whole process of digestion. It contains three ferments called ***amylopsin***, ***trypsin***, and ***steapsin;*** the first of which converts starch into sugar; the second, albumin into albuminoid; and the third changes fats and oils so they can be absorbed.

6. Spleen.—The function of the spleen is not well understood; but the chief uses are believed to be (1) making of blood corpuscles in very early life, (2) aiding in making the trypsin of the pancreatic juice, and (3) acting as a sort of reservoir for surplus blood during digestion. The spleen is located at the left of the stomach. It is about five inches long, four inches wide, and one inch thick, but varies greatly in size. The spleen is dark-colored, is called a "ductless" gland, has veins, arteries, nerves, and lymphatics, but excretes no fluid, and has no excretory duct. Excess of blood in the spleen will cause a pain in the side after violent exercise, as running.

OUTLINE SUMMARY

1. *Organs.* 1. Names—teeth, salivary glands, liver, pancreas, spleen.
   2. Use—aid in digestion.
   3. Glands—simple, as mucous glands, and complex, like liver.
2. *The Liver.* 1. Location—right side just beneath diaphragm.
   2. Size—about ten inches by six inches, and about three inches thick; weighs about four pounds.
   3. Parts—five *ligaments*, five *lobes*, five *fissures*, and five *vessels*.
   4. Structure—semisolid, muscular body, filled with tubes.
   5. Lobules—a mass of cells and tubes.

6. Vessels — portal vein, hepatic artery, hepatic veins, hepatic duct, and lymphatics.
7. Portal circulation — bad blood of stomach, intestines, and spleen collected by portal veins and carried to liver; changed by lobules and given back to general circulation.

3. *Bile.* 1. Color — a greenish yellow fluid.
   2. Composition — water, some salts, and a coloring matter.
   3. Use — a waste product, but aids in digestion.
   4. Amount — about a quart daily.
   5. Reservoir — the gall bladder and ducts.
4. *Glycogen.* 1. Definition — a starch made from sugar by liver.
   2. How used — converted into sugar again, and given out as needed, thus regulating the production of heat.
5. *Pancreas.* 1. Location — a gland lying behind the stomach.
   2. Size — varies; dimensions.
   3. Secretion — pancreatic fluid containing three ferments.
6. *Spleen.* 1. Location — left of stomach.
   2. Size — about five inches long, four inches wide, and one inch thick; it weighs five to eight ounces.
   3. Use — not well known.

QUESTIONS

1. Give location, size, and parts of the liver.
2. What is the minute structure of the liver?
3. Describe fully the portal circulation.
4. What is bile? Of what is it composed? What are its effects?
5. Describe glycogen.
6. Describe the pancreas. What is pancreatic juice, and what does it contain?
7. Give the location, size, and uses of the spleen.

CHAPTER XI

DIGESTION

1. Digestion Defined. — It must not be forgotten that the cell is the smallest unit of life. The cell works as long as it lives, and wears out as it works. If it is not fed regularly, it will live but a short time. As the cell wears away, its waste particles are taken up by the circulation and carried away. The blood must keep a sup-

ply of fresh materials for the cell all the time, and this material comes from the food. Cells cannot take up food in its ordinary state; food must be prepared for the cell. This preparation is called *digestion*. Food must first be ground into very small particles, then reduced to a liquid, and some chemical changes must occur in order to separate the nutrient portions from the waste particles of food. Digestion, then, consists of all the changes brought about in the food to prepare it for the blood.

2. **Organs.** — The three primary organs of digestion are the *mouth*, *stomach*, and *intestines;* these are aided by the secondary organs, namely, pharynx, esophagus, and all accessory organs.

3. **Steps.** — There are in digestion three principal steps and three subordinate steps. The principal steps are the saliva, or mouth digestion, the gastric or stomach, digestion, and the digestion of the intestines. Each principal step is followed by a subordinate step: *mastication*, or chewing, is followed by swallowing; *gastric digestion* is followed by the *passage* of chyme through the pyloric valve to the duodenum; and *intestinal digestion* is followed by *absorption*, or the passage of food to the blood.

4. **Digestion in the Mouth.** — Digestion in the mouth consists of two steps, chewing, and mixing food with saliva. While chewing goes on, saliva flows regularly and moistens the food; it acts on all starch in the food and changes it to sugar. When we are not eating, only enough saliva flows to make the mouth moist. Every one is familiar with "making the mouth water," which is merely making the saliva flow. Besides the act of chewing, the sight, odor, or thought of a favorite dish will make saliva flow. Smoking, chewing tobacco or gum,

and eating between meals cause much saliva to flow. This requires extra work and is hard on the glands. The spitting of tobacco juice alone will, in the course of time, injure the glands because of overwork and the waste of saliva.

In swallowing, the epiglottis closes to keep the food from going into the windpipe, the pharynx contracts, the esophagus receives the food, and by its wavelike motion passes it on to the stomach; thus the first step of digestion is completed.

5. Gastric Digestion. — When the food enters the stomach, it is composed of albumin, fat, and sugar. If digestion of the mouth is perfect, all starch is changed to sugar before it reaches the stomach, or soon after. This sugar is called glucose, or grape sugar. Saliva also converts cane sugar into grape sugar.

As soon as food enters the stomach, it is mixed with gastric juice, and reduced to a fluid called *chyme*. Gastric juice changes *albumin* to *peptones*, but has no effect on starch, sugar, or fat. The churning motion of the stomach is brought about by the action of the muscular membrane. The food is carried from the cardiac orifice to the pylorus, then back again; this process is continued until fat is broken into fine particles, albumin changed, and all food thoroughly mixed. When everything is ready, the pylorus opens, and the food, now called chyme, passes into the duodenum. In some cases of dyspepsia, food is passed on without complete digestion. Hard substances like buttons which are entirely indigestible are finally permitted to pass the pylorus. This completes the second step in digestion.

6. Intestinal Digestion. — The food receives, in the duodenum, bile, pancreatic juice, and intestinal juice; that part

of the chyme which may be converted is changed into a more perfect fluid state called *chyle*, and the remaining parts are passed on as waste matter. Bile, being a waste product, has little to do with the digestion of food except to aid the pancreatic juice. Intestinal juice has but little to do with digestion, but the three ferments of pancreatic juice are important. The first (amylopsin) aids saliva, and converts starch into sugar; the second (trypsin) converts albumin into albuminoids; the third (steapsin) emulsifies fat globules, dividing them into smaller particles, so they can be absorbed. The food is now ready for absorption, which completes the third and final step of digestion.

Chyle is a milky fluid which is readily absorbed, taken to the blood, and carried to the tissues for their nourishment.

7. Absorption. — The absorption of food consists in taking up the nourishing portions and carrying them into the blood. This is done by two sets of vessels, veins and lacteals. Veins of the mucous membrane of the alimentary tract absorb much food directly, especially glucose and water. Ordinary veins take up food and carry it into the general circulation. The portal vein, which has branches in the stomach and intestines, takes up much of the sugar and carries it to the liver, where it is converted into glycogen.

The lacteals are very fine threadlike tubes that begin in the villi of the small intestines. They have a transparent look, and take up fats chiefly, although they absorb all kinds of food. They are merely branches of larger tubes that finally unite in one large tube called the thoracic duct, which lies along the spinal column, back of the stomach, and empties into a great vein near the neck. Here food enters the general circulation.

Absorption goes on in the entire alimentary tract down to the point where the small intestine unites with the large intestine; some absorption goes on even in the mouth and in the esophagus. Enough poison may be absorbed by the mouth to produce death, and enough water to quench thirst. Plants and some low forms of animal life take up food only by absorption.

8. Assimilation. — The process of taking up food by the cells is called assimilation. Food is taken to the tissues by the blood. The tissues are continually changing, old cells are worn out and cast off as waste, and new ones take their place; this requires new material all the time. In the course of time the old material of any tissue will be replaced with new. Some cells naturally do more work than others, and both assimilate and wear out more rapidly.

OUTLINE SUMMARY

1. *Digestion.* 1. Definition — changes in food to prepare it for cells.
   2. Physical changes — food reduced to fine particles, fat emulsified.
   3. Chemical changes — starch to sugar, albumin to albuminoids.
   4. Foods not changed — water, grape sugar, and some minerals.
2. *Organs.* 1. General — all organs taking part in digestion.
   2. Primary — mouth, stomach, and intestines.
   3. Secondary — pharynx, esophagus, and all accessory organs.
3. *Steps.* 1. Principal — mouth, gastric, and intestinal.
   2. Subordinate — swallowing, passing the pylorus, and absorption.
4. *Saliva Digestion.* 1. Mastication — reduces food to fine particles.
   2. Mixing with saliva — moistens food and changes starch to sugar.
   3. Swallowing — passage of food to stomach.
   4. Injury of salivary glands — tobacco; eating between meals.
5. *Gastric Digestion.* 1. Foods in stomach — sugar, albumin, fat, water, minerals.
   2. Steps — mixture with gastric juice, and churning.
   3. Changes — albumin changed to peptones.
   4. Passage — food, now chyme, passes into duodenum.
6. *Intestinal Digestion.* 1. Juices — bile, pancreatic juice, intestinal juice.
   2. Ferments — amylopsin, trypsin, and steapsin.
   3. Changes — amylopsin converts starch to sugar, trypsin changes albumin to albuminoids, and steapsin emulsifies fats.

7. *Absorption.* 1. Definition — taking up food and carrying it to blood.
   2. Vessels — veins and lacteals.
   3. Place — whole alimentary tract.
   4. Forms — direct, by veins; indirect, by portal vessels and lacteals.
8. *Assimilation.* 1. Definition — taking up food by the tissues.
   2. Process — circulation brings food to cells, and takes waste away.
   3. Rate — some tissues change rapidly, others very slowly.

QUESTIONS

1. Define digestion. What are all the changes in the food?
2. What are the steps in digestion?
3. What changes does the mouth make in food?
4. What is meant by stomach digestion?
5. What is intestinal digestion?
6. Describe absorption.
7. Explain fully the process of assimilation.

CHAPTER XII

FOODS

1. Definition. — Food is a substance taken into the cells to sustain life. Foods aid in repair, in making new cells, and in making animal heat. All foods produce either *weight*, *heat*, or *energy*. Anything that builds up tissues or produces heat takes the general name of food; it may be in solid, liquid, or gaseous form. The things that cannot be converted into *chyle* are waste materials, and in no sense foods. Much of what we eat is not absorbed, but serves to keep the organs healthfully distended.

2. Animal Heat. — Heat is produced in the body by a process of burning called oxidation. Most fats are oxidized in the cells of the lungs, and most sugar in the cells of the liver. Exercise aids in making heat. The temperature of the body remains the same; it always, in health, stands at 98.5 degrees Fahrenheit. If the cells make too much heat, the surplus passes off by perspiration; if they do not make

enough, fresh air, good food, or a stimulant may be needed. The body has the power to regulate its own heat, and has about the same temperature whether the atmosphere has a temperature of 110 degrees above zero, or 40 degrees below zero. A part of the fuel for this heat is taken from the food, and a part is composed of the tissues of the body which are burned up to make way for the new cells that are being made all the time.

3. **Kinds of Foods.** — Foods that make heat are called *heat-producing foods*, and foods that make tissue are called *tissue-making foods*. Foods are divided into *proteids*, *sugar*, and *fats*. Proteids contain albumin, with other elements, and are the tissue builders; while sugar and fat contain carbon as their chief element, and are the heat producers. A perfect food contains the proper proportion of heat-making and tissue-making elements. The following is a convenient table of the different kinds of foods: —

1. *Albuminous Foods* or *Proteids*. (Tissue builders.)
    1. Albumin, as found in white of eggs.
    2. Casein, in milk and cheese.
    3. Fibrin, in lean meat.
    4. Legumin, in peas, beans, and other vegetables.
    5. Gluten, in wheat and other grains.
    6. Gelatin, in bones and fibrous tissues.
2. *Carbonaceous Foods* — Sugar, Starch, and Fat. (Heat producers.)
    1. Carbohydrates — carbon being the chief element.
        1. Sugar, including all foods that contain sugar.
        2. Starch, including all foods that contain starch.
        3. Gum.
        4. Cellulose, woody fiber indigestible in man.
    2. Hydrocarbons — hydrogen and carbon being the chief elements.
        1. Fat, butter, lard.
        2. Oils, as found in both vegetables and animals.

The above table does not include water and minerals. Sugar is found in most fruits, sugar cane, and beets, also

in small quantities in some grains and some garden vegetables. Starch is found in potatoes and grains. Fats are obtained from meats, butter, nuts, and seeds like cotton seed and castor beans. Good, pure milk and fresh eggs are almost perfect foods. A good meal should always have in proper proportion the three foods, *proteids*, *sugar*, and *fat*. If food is deficient in one or two of these, the body will suffer. In infancy the proportion should be, proteids two parts, sugar seven parts, and fat four parts; this proportion changes with age, state of health, and occupation.

4. Analysis of Foods. — All foods contain one or more of the five elements, proteids (albumin), sugar (starch), fats, water, and minerals. In the table below, the approximate average amount of these elements in many common foods is given: —

	Albumin	Sugar	Fats	Minerals	Water
Milk (cow's)	4%	5%	5%	1%	85%
Eggs	14%		15%	1%	70%
Meat	15%		14%	5%	69%
Fish	16%		7%	6% (about)	71%
Bread	15%	75% starch	6%	4%	
Potatoes	3%	22% starch		2%	73%
Beans	25%	60% starch	2%		13%
Cereals	10%	70% starch	2%	2%	16%
Corn	10%	70% starch	10%	2%	8%
Fruits	29% (varies)	20% to 30%			70% about
Green vegetables	Small amount	5% to 20%		Some nucleo-albumin	70% or more
Nuts	15% to 25%	15% to 20%	Considerable oil	Very little	Small amount
Tea		Only as a mixture	Considerable oil		70% to 85%
Coffee		Only in solution	Considerable oil		75% to 85%
Cocoa	Considerable		Considerable oil		75% to 85%
Candies	Only in mixture	30% to 50%			50% or more

5. Bad Foods. — One cannot be too careful about securing pure foods. Unripe fruits, unless cooked, are wholly unfit to eat. Such things as unripe apples should never be eaten, as they contain but little sugar, and their starch is in an undigestible state. Canned goods that have been exposed to the air are not good. Meats from diseased animals should never be used. Bread or meat covered with mold usually produces acute indigestion. Sour milk is usually unwholesome, and may even be dangerous. Any food that has an unnatural odor or taste should not be used. Most commercial candies are made of inferior materials and are unfit for use; also soft drinks at soda fountains are usually injurious or without value. All cooking should be thorough, the food well seasoned, and used only when fresh. There is no economy in bad foods, as they nearly always lead to distressing results. Bad meat contains disease germs. Many disease germs get into the system in bad food. It is possible to get consumption and some other diseases in this way. No raw meats should ever be eaten and very "rare" meats may be almost as injurious.

6. Choice of Foods. — In health, foods should be chosen with three ends in view: (1) correct proportion, (2) season of the year, and (3) economy.

The food eaten every day should have the proper proportion of proteids, sugar (or starch), and fat. People want things in season, and get "hungry" for a certain dish, because foods previously used were out of proportion, one or more element being absent.

Our bodies lose heat rapidly in winter, thus requiring much more of the heat-making foods, as sugar, starch, and fat. The opposite is true in summer. Occupation must be considered, too, in choosing food. Except in certain

diseased states, the greater part of food used should be of the heat-making class. Good, pure food is always cheapest. Only foods that nourish well can ever be cheap, but many high-priced foods do not nourish so well as good food of medium price. Cheap meat and fish, if good, will nourish as well, usually, as the more expensive, provided cooking is well done. Plain breadstuffs are much cheaper and better than those ready mixed, and always make better bread.

OUTLINE SUMMARY

1. *Foods.* 1. Definition — substances that aid the function or sustain the life of the cells.
   2. Work — repair, aid in making new cells, and animal heat.
   3. Products — weight, heat, and energy.
2. *Animal Heat.* 1. How produced — by oxidation.
   2. Special oxidation — fat chiefly in lungs, and sugar mostly in liver.
   3. Constant temperature — 98.5 degrees.
   4. Extremes — excess is thrown off, and deficiency made up.
   5. Materials — oxygen from air, and carbon from food and worn-out tissues.
3. *Kinds of Food.* 1. As to effects — tissue making and heat making.
   2. As to contents — tissue making, nitrogen and carbon; heat making, carbon.
4. *Analysis of Foods.* 1. Contents. Make statement.
   2. Analysis — see table.
5. *Bad Food.* 1. Immature foods — unripe fruits, poorly cooked and stale foods.
   2. Infected foods — diseased meats, decayed foods, and spoiled milk.
   3. Impure foods — most soft drinks, cheap candies, and poor pastry, and adulterated foods.
6. *Choice of Foods.* 1. Proper proportion — foods out of proportion will soon make one "hungry" for certain dishes.
   2. Season — foods should suit season.
   3. Economy — good foods of medium price.

QUESTIONS

1. Define food. How does a food differ from a poison?
2. Explain how and where animal heat is produced.
3. What are the kinds of food? What do foods produce?
4. What are pure foods? What is a perfect food?
5. Why does one become "hungry" for some one food?

CHAPTER XIII

FOODS (*continued*)

1. Digestibility of Foods. — Digestion depends upon mental, physical, and chemical agents. When one is happy, contented, and hopeful, food digests much more easily; sadness and fright affect the excretions and make digestion more difficult. If mastication or muscular movement be poor, digestion is disturbed, and in many cases prevented altogether. The former leaves food so coarse that it sometimes passes without any degree of digestion, and the latter may result in an obstructed intestine, and may even produce death. The chemical action of foods must be perfect at every point, or fermentation will set up in the form of sour stomach, or gas; digestion will not take place, and both the nerves and alimentary tract may be sorely distressed and weakened. In the valuing of foods, several things must be considered: —

(a) *Strength.* — Foods containing much fat produce more heat and energy than those containing a similar amount of sugar or starch. Fat requires nearly three times as much oxygen as sugar, and produces, therefore, much more heat and energy, in a state of health.

(b) *Purity.* — Nearly all foods contain some indigestible matter. It is probably true that more than half of all we eat is mere rubbish and is worked off at a great loss of vitality. Only a small amount of fruit is digested. Fat from animals is easily emulsified, but oil from vegetables is difficult to emulsify, much of it passing as waste. Very little of good meat is not digested.

(c) *Resistance.* — Some foods are easily digested, others with difficulty; some are digested in a few minutes, others

require hours. Those that are easy to digest should be chosen. Most mixed foods, as mince pie, require more time and energy than the same foods if taken singly. As a general thing albuminoids digest quickly; oils require more time; and salted pork, cabbage, and heavy breads require several hours.

FIG. 30. — Fermentation in a jar of cherries.

(d) *Fermentation.* — Sugar and starch ferment much more easily than fat, and albuminoids seldom ferment if gastric digestion is good. The longer any food remains in the stomach, the more likely it is to ferment. Eating too much aids fermentation.

(e) *Assimilation.* — Some persons assimilate more easily than others; almost every one will assimilate some foods more readily than other foods. These facts should influence one in choosing food. One should choose those articles most easily assimilated. A full stomach, with hungry tissues, is a bad condition.

2. **Milk.** — Pure milk is the most perfect food known, containing proteids, sugar, fat, water, and some minerals; in good milk these are usually in correct proportions. Milk makes heat and energy in the body about as needed, and is so easily digested that it can be taken when no other food can. As it is very liable to contain injurious germs, it should be used only when pure. The germs of typhoid fever and consumption frequently get into milk, and people drinking it get these diseases.

(a) *Casein* is the name of the albumin in milk. Milk should be taken slowly, so its albumin can be changed to

peptone as fast as it reaches the stomach; otherwise it may gather in lumps and ferment. When milk sours, its casein coagulates, forming *clabber*.

(b) *Cheese* is composed of coagulated and compressed casein; it contains the fat, also, of milk, but the sugar is left in the whey. Composed of albumin and fat, cheese is a valuable article of food.

(c) *Butter* is one of the best fats known. Cream from which it is made is composed of fine particles of fat held together by casein. When cream is whipped or churned until the casein is separated from the fat, the particles of fat unite in a firm mass called butter. Casein separated from the fat is called buttermilk, and is a good food. It has very little fat left, and has lost some of its sugar, but it has an abundance of albumin.

(d) *Condensed Milk* is made by boiling ordinary milk and evaporating its water until a jellylike substance remains. Sugar is sometimes added to preserve it. This is a good food, and is used in cooking, but is not a very desirable food if it has much sugar. Unsweetened condensed milk is usually called evaporated milk.

3. Eggs. — By reference to the table, it will be seen that eggs contain no sugar or starch. The white of an egg is almost pure albumin and water, and the yolk is albumin, fat, and water. To make the egg a perfect food, some starch or sugar must be taken with it. It is easily and quickly digested and oxidized.

An egg is most easily digested when raw; it is easily digested when the white is cooked to a semifluid, and the yolk entirely fluid; it is difficult to digest when cooked until the white is tough and the yolk a pasty mass; and is easily digested when cooked until the white is brittle and the yolk crumbles.

These statements refer to *fresh eggs* only. Old eggs are not wholesome. The shell is porous and the water evaporates, which breaks up the proportion somewhat, and begins decay. Fresh eggs are known by color, surface, and appearance when held before a light.

4. Meat. — Nearly all meats are much alike. In good meat, albumin and fat are nearly equal in amount. The composition of meat is similar to that of eggs, neither containing sugar or starch. It ranks high, standing next to milk and eggs. Beef is the best form, with mutton, fowl, venison, pork, and game ranking next in the order named. Meat is easily digested, produces a large amount of heat, and is a good tissue builder. It does not ferment easily. Tough meat contains strong fibrous bands of connective tissue. It may be made tender only by pounding until the fibers are broken up. The nutritive parts are the muscular fiber and fat. In order to make meat a complete food, it must be eaten with something that will supply the elements it does not contain, as starch in the form of bread, or some form of dressing containing sugar.

(a) *Curing Meat.* — The chief point in curing meat is to prevent the entrance of germs. This may be done by surrounding it with salt or sugar, or by exposing it to smoke, or by putting it into brine. It may be dried, also, until an outer layer is formed hard enough to prevent the entrance of germs. If meat is thoroughly drained of blood when dressed, and protected from insects, it may be hung up in the open cold air and kept almost indefinitely. Spoiling is a form of rot due to the action of germs; if these germs can be kept away, meat will keep.

(b) *Beef Products.* — The chief products of beef are *soup*, *extract*, and *tea*. Soup is composed of particles of fat and gelatin held in suspension, and is usually flavored

and enriched by the addition of some other nutritious articles, as butter, scraps of vegetables, or small fragments of meat. Beef extract, or beef juice, is made by heating and compressing meat and forcing its juice out. This is a good article of food, containing about equal proportions of proteids and fat. Beef tea is somewhat like soup, but is not a valuable food because it has little albumin or fat, and no sugar.

(c) *Fresh Meat.* — Most meat, if hung in a cold room, will become more tender with age. If hung out in the open air when the weather is warm, meat will spoil in a few hours. The practice of hanging up the bodies of game animals without any draining or dressing, and keeping them until they begin to decay, in order to develop a high flavor, is bad, and should be discarded. No decayed meat can ever be made wholesome by cooking and seasoning. Fish and fowl spoil quickly, and when spoiled are dangerous. All animals should be opened and cleaned as soon as they are killed, unless the weather is very cold; otherwise they should never be used for food. Meat, to be good, should be tender, having a small amount of connective tissue, a good odor, and a uniform color. It should be firm, elastic, and clean.

5. **Fish and Fowl.** — Fish and nearly all forms of sea foods are very wholesome, if untainted. Most of such foods decay very soon when exposed to the air. Oysters are more easily digested when raw, and are an excellent food for people having delicate stomachs. They may contain germs if the beds are near the mouth of some polluted stream, but cooking will remove this danger. Clams and crabs are wholesome foods, but decay very quickly unless preserved in some way.

Fish are rich in albumin and fat, but not quite so good

a food as beef. Oysters and clams are about as rich in albumin as fish, but not so rich in oils or fat. They contain also a small amount of sugar.

Poultry is very nourishing, and easy to digest. It produces much heat and energy, and ranks high as a delicate food; and it is an excellent food for the sick.

OUTLINE SUMMARY

1. *Digestibility of Foods.* 1. Forces — mental, physical, and chemical agents.
   2. Value — depends upon strength, purity, resistance, fermentation, and assimilation.
2. *Milk.* 1. Parts — almost equal parts of proteids, sugar, and fat.
   2. Casein — the albumin of milk; coagulated, it is clabber.
   3. Cheese — made from casein, and some fat.
   4. Butter — the fat taken from milk. Residue? Value?
   5. Condensed milk — evaporated milk with some sugar added.
3. *Eggs.* 1. Parts — white, almost pure albumin and water; yolk, albumin, fat, and water.
   2. Digestibility — most easily digested when raw, or when white cooked to a semifluid and yolk entirely fluid; hard to digest when white tough and yolk pasty mass, but easy when white brittle and yolk hard enough to crumble.
   3. Age — fresh eggs only are wholesome. How determined?
4. *Meat.* 1. Parts — albumin and fat almost equal.
   2. Rank — high; beef is best, then mutton, fowl, venison, pork, and game, in order named.
   3. Tough meat — due to tough connective fibers.
   4. Nutrition — nutritious parts are muscular fiber and fat.
   5. Curing — to prevent entrance of germs, cover with salt, sugar, or soot; it may be pickled or dried. Spoiling due to germs.
   6. Beef products — soup, extract, and tea.
   7. Fresh meat — will keep fresh if hung in cold room; in open air will spoil in a few hours. No decaying meat can be made good by cooking.
5. *Fish and Fowl.* 1. Sea foods — wholesome if fresh; decay easily; oysters better when raw, but may be infected; clams and crabs good.
   2. Fish — rich in albumin and fat; delicate food, if fresh.
   3. Poultry — ranks high, very nourishing, easily digested.

QUESTIONS

1. What is digestibility of foods? Upon what does the value of foods depend?

2. What are the food elements in milk?
3. What food elements do eggs contain?
4. State the rank of the different meats as food.
5. How should meats be cured? What are the nourishing elements in meat?
6. What kind of food are fish and fowl?

CHAPTER XIV

FOODS (*concluded*)

1. **Bread.** — Bread, "the staff of life," is made from various grains. It may be composed of the simple crushed grain, some water and a little salt, or may be very complex, containing several ingredients.

(a) Bread is composed of albumin, starch or sugar, fat, and minerals, usually more than half of it being starch. It is, therefore, a very valuable food. Because of the large quantity of starch, it is not very easy to digest, and fermentation at some point in the alimentary canal is very likely to occur, unless an equal amount of animal food is taken with it.

(b) Gluten is the name of the albumin of grains, and is very similar to animal albumin; it is a little more difficult to digest than animal albumin, a larger part of it remaining undigested, but it produces about the same amount of heat and energy.

(c) Plain bread is merely a mixture of water or milk, and the grain crushed to small particles, and some salt. Plain bread is very compact. To make it porous and light, yeast is added. This acts on the native sugar in the grain, and produces a gas which makes the bread porous and light. Baking powder is used for the same purpose.

Biscuit is made from flour, milk, yeast or baking powder,

and fat, usually in the form of lard. The lard makes it more indigestible.

Corn bread is made of corn meal, milk, and fat; sometimes eggs are added. It contains more native fat than any other bread, and is easily digested.

Pancakes are plain bread and may be made of corn meal, wheat flour, or buckwheat flour.

Cracked wheat in its various forms is of about the same value as bread, but oatmeal is not so valuable, as it is more difficult to digest. Oatmeal is good to stimulate peristalsis.

Rye bread is made from rye flour, and ranks high as a food.

Rice and *barley* are poor in albumin but rich in starch. Rice is easily digested, and, combined with something to supply its wanting parts, is widely used. It stands high as a food.

2. Beans. — Beans and peas are so nearly alike that they may be described together. They are very rich in starch and albumin, but have little fat. They are not very easy of digestion because of the large amount of starch, and are liable to ferment. They are valuable foods for almost any one in a state of health, and when well cooked and seasoned are very nourishing. The albumin in beans and peas is called *legumin.* They should be served with fat or butter in order to supply the missing element.

3. Potatoes. — About three fourths of the potato is water, and nearly one fourth is starch. It has only a small amount of albumin, and no sugar. The potato is a high-class food, and a good substitute for bread with meat. It is easy to digest, and not very likely to ferment unless taken in large quantity.

4. Green Vegetables. — Turnips, parsnips, celery, spinach, beets, carrots, tomatoes, cabbages, onions, asparagus, cucumbers, melons, green beans, and a few others are called green vegetables; some are very good foods, others are poor. Some of them contain considerable starch, but most of them contain much indigestible fiber.

Beets, turnips, parsnips, and pumpkins should never be eaten raw, but should be thoroughly cooked to break up their indigestible fiber. Tomatoes may be eaten raw, but not until ripe. The tomato has some cathartic properties, and aids in the digestion of other foods. Cabbage may be eaten raw, but is best when well cooked. It requires more time to digest than any other vegetable. Onions may be eaten either raw or cooked; they act on the liver and skin. The cucumber, when fresh and unwilted, has a fine flavor, but is of little food value.

5. Fruits. — Fruits differ greatly in the amount of albumin they contain, but nearly all have an abundance of sugar, and some contain oil in small quantities. They are very useful for their flavor, and for exciting peristalsis when eaten with foods that yield little residue as waste matter. Because of the excess of their sugar, fruits are more or less liable to fermentation. Most of them are easily digested and a valuable food.

Apples, peaches, pears, and cherries have considerable albumin and a large quantity of sugar. They may be eaten raw, if ripe. They are easily canned, and easily preserved in sugar. In any form, they are good food, and when ripe may be eaten in abundance.

Berries of all kinds are much alike, not very rich in albumin, but rich in sugar. They make a good food when cooked and served with something containing some albumin and considerable fat. Grapes and bananas contain much

more albumin than most fruits, and much sugar; the banana contains some oil. Both are good foods, especially when supplemented. The sugar of grapes is glucose, or grape sugar, the form of sugar produced by digestion. Fruit too ripe, or decayed, should not be used, as it may contain germs that will produce sickness. When ripe, in season, and wholesome, one can eat fruit in almost as large quantities as his system demands. Some fruit should be eaten by every one every day.

6. **Nuts.** — Most nuts are rich food. They have albumin, starch, and oil. They are rich in both albumin and starch. All their ingredients are rather hard to digest, and while a good food, they should not be eaten in large quantities, especially after a good meal, or late at night.

7. **Salt.** — Common salt is found in nearly all foods, but not in sufficient quantities to preserve the food or to satisfy the taste. It acts upon the salivary gland as a stimulant. Salt is not really a food, but aids in digestion by bringing out the natural flavors of foods; its excessive use may become a habit. The body is said to contain from one half to a pound of salt all the time.

8. **Mineral Foods.** — This class contains water, which will be discussed in another chapter, and salts, chief among which is common salt, above described; others are salts of magnesia, potash, and lime. There are also small amounts of iron in the body. All these salts and the iron come from the various articles of food.

9. **Spices.** — Spices include such articles as red pepper, black pepper, mustard, cloves, nutmeg, cinnamon, allspice, ginger, and some others. None of these are hurtful if not used to excess; they are not foods; they aid diges-

tion by their flavors, and their stimulating effect upon the glands. The peppers, mustard, or ginger may injure a sensitive stomach, if strong or used to excess. Habit is an important factor in the use of nearly all of them.

OUTLINE SUMMARY

1. *Bread.* 1. Form — simple, composed of crushed grain, water, and salt; or complex, containing several ingredients.
   2. Composition — albumin, starch, or sugar, fat, and some minerals; more than half starch.
   3. Kinds — plain, biscuit, corn bread, pancakes, rye bread, cracked wheat, rice, and barley. Give ingredients of each.
2. *Beans.* 1. Parts — rich in starch and albumin, but have little fat.
   2. Digestion — not very easy; liable to ferment; very nourishing.
3. *Potatoes.* 1. Parts — three fourths water, nearly one fourth starch; a small amount of albumin.
   2. Rank — high, very digestible, and may take place of bread.
4. *Green Vegetables.* 1. Kinds — make statement.
   2. Value — some good, others poor; valuable mainly for flavor, taste, *nucleoalbumin*, and for causing peristalsis.
5. *Fruits.* 1. Parts — much sugar, vary in albumin, and a few have some oil.
   2. Value — flavor and peristalsis, but liable to fermentation.
6. *Nuts.* 1. Value — rich food; contain albumin, starch, and oil.
   2. Digestibility — rather hard to digest.
7. *Salt (common salt).* 1. Value — not a food; aids digestion by stimulating glands.
   2. Salt habit — too much salt may cause disease.
8. *Mineral Foods.* 1. Contents — water and mineral salts.
   2. Value — useful for supplying the body with many minerals.
9. *Spices.* 1. Kinds — peppers, mustard, cloves, and many others.
   2. Value — not foods, but aid digestion.

QUESTIONS

1. What are the forms and composition of ordinary breads?
2. How do beans and potatoes compare as foods?
3. What are the chief green vegetables, and what their value as foods?
4. What are the food elements in fruits? Nuts?
5. What are the mineral foods?
6. What value have salt and spices?

Air and Water Contamination.

CHAPTER XV

DRINKS — WATER

1. Water. — Water constitutes two thirds to three fourths of the body. Water is the largest part of nearly all drinks, and is a part of nearly all vegetable and animal foods. *Hard water* holds lime in solution, while *soft water* has no lime. Water is a necessity in the system for (1) softening food, (2) to aid the movement of all materials in the body, both foods and waste material, (3) to regulate the heat of the body, and (4) to maintain proper bulk in the tissues. There is water in every tissue, even the bones and teeth.

2. Composition. — Pure water is composed of hydrogen and oxygen. In weight, there is one part of hydrogen to eight of oxygen, but in bulk there are two parts of hydrogen to one of oxygen, the chemical formula being H_2O. Pure water is not often found in nature; the only way to get it is to distill it. Water absorbs gases and dissolves solids so readily that it is soon laden with other substances, many of which are impurities. It takes up foreign materials from the soil, the rocks, decaying objects, and the atmosphere. It takes something from almost everything it touches. It may hold in solution many salts, poisons, and acids, or contain germs of disease.

3. Amount of Water Needed. — The amount of water required by a healthy man in a day is from 80 to 100 ounces, or from five to six pints. This is only a rough estimate, based on averages. The amount needed depends upon many things, as occupation, climate, and season of

year. To be healthy, one should drink much water; as a rule, women do not drink enough.

4. Impure Water. — Water may be clear and sparkling and yet contain impurities or disease germs. The taste of water may not reveal its impurities. Most of the things found in water are harmless, and improve its taste. Still water is much more likely to be impure than running water. Water in most small streams is good, but in most ponds near barns and outhouses it is very likely to be impure; ice taken from such ponds is as impure as the water; water standing in bad pipes may take up poisonous matter. Nearly all harmful things in water are either decaying matter or living disease germs. No slops, decaying substances, or waste from the body should be permitted in the immediate neighborhood of the well, spring, or cistern. In this way the germs of typhoid fever may get into drinking water, and produce the disease. The way to destroy disease germs in water is to boil it.

5. Tests of Water. — If an open glass of water be put in a warm place, and in two or three days it has a foul odor, it is unfit for drinking purposes. Since the open water may take up germs after the test begins, this is not a very reliable test. The following is a better test: Dissolve two grains of permanganate of potassium in about an ounce of distilled water. Put enough of this solution in a half glass of the water to be tested to give it color, and let it stand several hours. If the color fades out, the water has organic matter in it, and is unfit for use; if the water retains its color, it does not contain any organic material.

A physician may make a microscopic test for bacteria. Another test is to put some pure sugar in a glass of water

and set it aside for a time; if it acquires a yellow tint, it contains organic matter; if it remains clear, it has no organic matter, and is perhaps safe. Another test is known as "Nessler's test." Put a few drops of Nessler's solution in a half glass of water. If a yellow or brown color is produced, the water contains organic matter and is dangerous.

6. Dangers from Bad Water. — The chief dangers from bad water are (1) diseases due to germs; (2) diseases due to minerals in water and poisons; and (3) eggs and embryos of parasites. Of the first, typhoid fever is a notable example; injury of the stomach by strong medicines, as lead and copper poisoning, illustrates the second case; and tapeworm, intestinal worms, and trichina illustrate the third class.

7. How to purify Water. — Water may be purified by *boiling*, *filtration*, *oxidation*, *ventilation*, and by use of *chemicals*. Boiling water for a few minutes destroys all disease germs or eggs. Filtration consists in passing water through layers of sand or charcoal, which removes all mud and other suspended matter, but does not always remove all disease germs. Oxidation of many impurities takes place as water soaks down through the soil, or moves in a running brook, and by the action of the air and sunlight. In ventilation, the air will take up many impurities. Ventilation is effected by mixing air with water. Water may be purified by action of lime, or some of the acids.

8. Water in Foods. — About one third of the water needed by the average person comes from the foods he eats. If coffee, milk, and tea are used, much water is taken through them, since they are mostly water; then if fruits and melons are much used, this will modify the

amount of water needed. The amount of water in foods varies from 5 per cent to 95 per cent.

9. **Cistern Water.** — A cistern is safe only when it is so well built that no surface water can soak in or fall in through the top. Water must be pure when put into the cistern, and ventilated by something like a chain pump. It is well to clean the cistern once a year before filling, and as soon as it is filled put about a half bushel of unslaked lime in, which will have a tendency to keep the water pure and improve its taste. If a cistern is not perfectly safe, its water is more dangerous than any other water.

10. **Well Water.** — In a well the water rises as high as the reservoir of its vein. As water is removed the well fills again, this being the only circulation the water has. It is better when the well is used regularly. This water can be good only when the reservoir, vein, and well are protected from surface water. If the water rises in the well after a rain, or becomes muddy or milky after a rain, it is dangerous. This means that it is being fed by surface water, and is so near the surface that the water cannot be filtered and purified as it trickles down through the earth. The water from a drilled well, when deep enough and well piped, is the purest of all well water.

11. **Spring Water.** — Spring water is usually very pure, unless its reservoir or vein is supplied with surface water, made impure by waste water from some factory, distillery, or cemetery. If it is muddy or milky after a rain, it is dangerous. A spring should be kept clean, protected by a wall laid in cement, covered and protected against fowls, reptiles, and stock. Its water should flow off freely from its basin.

When typhoid germs get into a well or cistern, it is almost impossible to remove them; the well or cistern should be filled up, and a new one made, as it may save many lives. The water of a reservoir for a city should be thoroughly filtered; if exposed to germs of typhoid fever, it should always be boiled before being used for drinking.

OUTLINE SUMMARY

1. *Water.* 1. Quantity — constitutes three fourths of body and the larger part of all foods.
   2. Solvent — seldom found pure; holds in solution salts, minerals, poisons, and bacteria.
   3. Work — softens food, and aids in circulating materials in body; regulates heat and makes bulk.
2. *Composition of Water.* 1. Parts — hydrogen and oxygen.
   2. Purity — made pure by distillation.
3. *Amount Needed.* 1. A healthy adult — about three quarts a day.
   2. Average in foods — about a quart a day in foods.
4. *Impure Water.* 1. Appearance — water may be clear, and yet contain impurities.
   2. Movements — running water in small streams usually pure; still water usually impure.
   3. How purified — by filtration, oxidation, and ventilation.
5. *Test of Water.* 1. Physical — by evaporation, and testing residue; also, by microscope.
   2. Chemical — describe Nessler's test.
6. *Dangers from Bad Water.* 1. Germs — disease due to germs.
   2. Irritation — disease due to irritation of alimentary tract, poison, and minerals.
   3. Parasites — eggs and embryos of parasitic animals.
7. *How to purify Water.* 1. Mechanical — boiling, filtering, etc.
   2. By chemicals.
8. *Water from Foods.* 1. Amount — varies from 5 per cent to 95 per cent.
   2. Average — 65 per cent.
9. *Cistern Water.* 1. Safety — safe only when perfectly protected from all surface water, well ventilated, and purified.
   2. Purity — either best, or most dangerous, of all water.
10. *Well Water.* 1. Safety — safe only when protected from surface water.
    2. Open well — always dangerous.
    3. Bored wells — best of all when deep and well piped.

11. *Spring Water.* 1. Purity — naturally very pure.
2. Danger — may be poisoned by water from factory, barns, cemetery, or surface water.

QUESTIONS

1. How does water aid digestion? What is the composition of water?
2. What quantity of water is needed by a healthy person?
3. What are the tests for impure water?
4. What are the dangers from bad water?
5. Which one of these is safest, cistern water, well water, or spring water?

CHAPTER XVI

DRINKS — BEVERAGES

1. Beverages. — All drinks except water and milk may be considered as beverages, that is, used merely to gratify the taste, or to satisfy a habit. They are not foods, and may be put aside entirely without any injury. In fact, it is injurious to use most of them, especially when used to excess, or used as a habit. Beverages may be divided into two classes: (1) those containing alcohol, and (2) those without alcohol. The leading alcoholic drinks are the *fermented liquors*, as the beers and the wines, and the *distilled liquors*, as whisky, brandy, gin, and rum. Fermentation in some form is involved in the making of all alcoholic drinks, but by fermented liquors we mean those that are made by fermentation only. Distilled liquors are made by a process of distillation after fermentation has done its work.

2. Distillation. — The principle of distillation is very simple. Substances to be distilled are composed of water, volatile oil, alcohol, and some other substances. The volatile oil and alcohol vaporize more easily than water, and can be driven off from the water and other substances by

heat. The material to be distilled is placed in a still, which has a long pipe arranged in coils descending through a tank of cold water. Heat is applied to the still, the alcohol and oil are driven off, while water and the other things are left in the still. The vapor passes off through the coiled pipes, is condensed again into liquid form, and runs off as whisky or some other distilled product. If distillation begins with grain, the starch of the grain is converted into sugar by malt. The sugar is changed to alcohol by fermentation, and the alcohol and oil driven off from the substances with which they are mixed, by heat. In condensing the alcohol, some water will be condensed with it. To get rid of the water, it is necessary to redistill with something that will absorb the water.

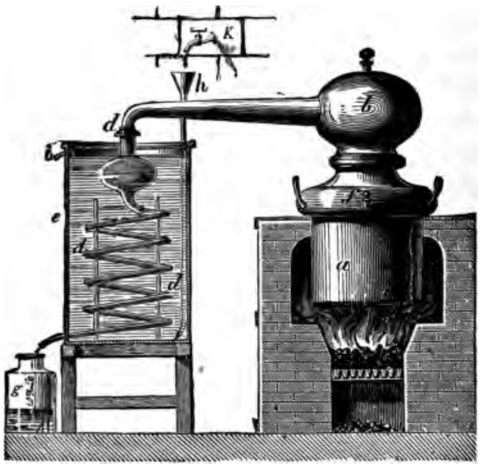


FIG. 31.—A still.

a, f, b, c, d, retort in which the liquid is changed to vapor; *d, d*, worm; *K, h, e, i*, cooler and arrangements for condensing the vapor in the worm.

3. Beers.—The beers contain from 2 to 6 per cent of alcohol, and are mild beverages. They contain a bitter narcotic taken usually from hops. Beer is usually made from barley, and is fermented by means of yeast, which converts sugar to alcohol. The foam of beer is produced by carbon dioxide made by fermentation. Beer

may be made from many other grains, as corn, rye, millet, and rice. It may be made from milk. Beers contain but little nutrition.

4. **Wines.**—Wines are fermented without yeast, and take an acid from the fruit from which they are made; they contain more nutriment than beers. Fermentation is brought about by germs from the air. Wines contain from 3 to 30 per cent of alcohol. Wines are made from the juice of many things, as apples, the sap of palm trees, sugar corn, juice of century plant, berries, cherries, grapes, and many others. Most wines are adulterated by the addition of alcohol, sugar, flavoring extracts, and some coloring matter.

5. **Whisky.**—Good whisky contains more then 50 per cent of alcohol. It contains an oil, which makes its flavor, and water. It may be made from any grain containing starch, as rye, wheat, or potatoes, but it is usually made from corn. To the corn is added some malt, which is made from barley. This changes the starch to sugar, and the sugar is changed to alcohol by vinous fermentation. The substance is then distilled, by which whisky and its oil are made.

6. **Brandy.**—Brandy is made by distilling wine, usually of peaches or apples. It contains alcohol, water, and an oil, which gives its flavor. A good average brandy contains about 60 per cent of alcohol, and is therefore very intoxicating.

7. **Gin.**—Gin is made by adding juniper berries to the grain that would otherwise make whisky. The process of distillation is practically the same as that of whisky. The berries give the flavor.

8. **Rum.** — Any substance that can be distilled may be greatly modified by adding one or more other substances that will undergo distillation. Ordinary molasses can be fermented by adding some yeast or other ferment. From fermented molasses, rum is made.

9. **Coffee.** — The active principle of coffee is *caffeine*, a drug; it also contains a volatile oil and some acid. Coffee is not a food, but a stimulant. It excites the cells to do more work, but does not produce either heat or energy. In stimulating cells to do more work, coffee often relieves fatigue, or enables one to do more work, or to stand a strain, but in the end it results in a depression. It produces nothing; it merely calls forth latent energy and uses it, resulting in a loss. For this reason the habit of drinking coffee should never be formed. If one would use it only when a mild stimulant is needed, there could be no objection to its use; but when failure to get it for a meal or two gives one a headache, the habit is doing great injury. It finally attacks the nerves, producing serious nerve disorders, and through the nerves injures all vital processes.

10. **Tea.** — The action of tea is very similar to that of coffee. Its active principle is called *theine*, a stimulant. Tea was formerly used as a medicine. Tea, like coffee, contains a volatile oil, and some tannic acid. The oil they contain is the chief factor in the headache and nervousness they produce.

11. **Chocolate.** — Chocolate is a pasty solid made by grinding the seed of the cocoa tree. It is often flavored with vanilla and sweetened. Chocolate contains an oil and some starch, and is to a certain extent nutritious. From it is made a good mild drink which is not followed by depression or exhaustion.

12. Lemonade. — Some people have too much acid in the stomach, and cannot well digest lemonade, but with most people it is a very useful drink. Lemonade should be sweetened until it tastes good, and drunk slowly. Besides the general effect, lemon juice is a good disinfectant.

13. Cider. — Sweet cider is merely the juice of apples. Besides being a harmless beverage, it contains sugar, which gives it value as a food. When it begins to ferment, its sugar is being changed to alcohol. After it ferments it is called *hard* cider, and contains enough alcohol to make one drunk. From this alcohol vinegar is made.

14. Grape Juice. — The sugar in grape juice is glucose. Because of its purity and the kind of its sugar grape juice is one of the very best of drinks and is also a good food. It excites the flow of saliva, which makes it a valuable aid in digestion. If such drinks as this, lemonade, and sweet cider could take the place of most drinks at the soda fountain, people would be better off.

15. Soda Water. — While soda water is not necessarily injurious, it may be. It does not contain any soda. It is merely a mixture of a sirup and water containing a large amount of carbon dioxide, which is forced into the water by pressure. This gas is harmless taken in this way, and if the sirup is good, the drink is not injurious. Poor sirup may make the drink injurious.

16. Ginger Ale. — This drink contains ginger and some alcohol. It is a mildly stimulating drink.

17. Chicory. — Chicory is the root of a plant, and is extensively used as a substitute for coffee. It is much cheaper than coffee, and contains an oil something like that of coffee and tea. It is sometimes used to adulterate coffee. It has no value as a food, and should not be used.

18. Phosphates. — Orange and cherry phosphates are good, refreshing drinks when the sirup used is good; they have a medicinal effect. When properly made, they may be used either for this purpose or as a beverage.

OUTLINE SUMMARY

1. *Beverages.* 1. Definition — drinks to satisfy taste or habit.
   2. Kinds — alcoholic and non-alcoholic.
2. *Distillation.* 1. Process — alcohol vaporized by heat and then condensed.
   2. Steps — changing *starch* to *sugar*, *sugar* to *alcohol.*
3. *Beers.* 1. Contents — 3 per cent to 6 per cent of alcohol and water; also a narcotic taken from hops.
   2. Materials used — usually barley, but many other grains may be used.
4. *Wines.* 1. Contents — 3 per cent to 30 per cent of alcohol.
   2. Materials used — juice of many fruits.
5. *Whisky.* 1. Contents — more than 50 per cent of alcohol; oil.
   2. Materials — rye, wheat, corn, or potatoes.
6. *Brandy.* 1. How made — by distilling wine.
   2. Contents — about 60 per cent alcohol; oil.
7. *Gin.* 1. Materials — same materials used to make whisky, with juniper berries added.
   2. How made — fermentation and distillation.
8. *Rum.* 1. How made — from fermented molasses.
   2. Amount of alcohol — rather large.
9. *Coffee.* 1. Contents — caffeine, a volatile oil, some acid, and water.
   2. Effect — stimulant, exciting some cells to action.
10. *Tea.* 1. Contents — theine, a volatile oil, tannic acid, and water.
    2. Effect — a stimulant, acting very much as coffee.
11. *Chocolate.* 1. Contents — contains oil, starch, and water.
    2. Value — a good mild drink, and has some food value.
12. *Lemonade.* 1. Value — good drink for those without much acid.
    2. Other use — a good disinfectant.
13. *Cider.* 1. Sweet cider — apple juice, contains sugar; a good food.
    2. Hard cider — sugar changed to alcohol by vinous fermentation.
14. *Grape Juice.* 1. Contents — glucose, vegetable acid, and water.
    2. Digestant — excites flow of saliva; a good drink and food.
15. *Soda Water.* 1. Contents — mixture of sirup and water charged with carbon dioxide.
    2. Danger — may be harmful if sirup is bad.
16. *Ginger Ale.* 1. Contents — some alcohol combined with ginger.
    2. Use — a mild stimulant.

17. *Chicory*. 1. Contents — oil something like coffee and tea.
    2. Value — no value, and should not be used.
18. *Phosphates*. 1. Kinds — chief kinds are orange and cherry.
    2. Value — good, refreshing drinks, with medicinal effect.

QUESTIONS

1. What are beverages? What is the process of distillation?
2. How are the following made? *beer*, *wine*, *whisky*, *brandy*, *gin*, and *rum*.
3. What are the contents and effects of *coffee*, *tea*, and *chocolate*?
4. What is the value of such drinks as *lemonade*, *cider*, *grape juice*, and *soda water*?
5. What is the effect of the phosphates taken in drinks?

CHAPTER XVII

HOW TO MAKE GOOD DIGESTION

1. The Appetite. — The purpose of digestion is to nourish the body. The needs of the body must determine the amount of food, the kind of food, the manner and time of eating, and the drinks to be used. One should never eat or drink merely for the pleasure of it, nor should one eat unless the act is attended by pleasure. Nature's way of making the want of nourishment known is by two feelings, called *hunger* and *thirst*. These feelings may be *general*, demanding any good food or drink; or *particular*, demanding a single article of food, or some one drink. This special feeling is called taste, and determines what food or drink should be used at a given time. It aids us in selecting foods and drink at every meal. Taste may be as natural and reliable in man as it is in the lower animals, or it may be deranged and unnatural, as the taste of a drunkard for liquor. The lower animal follows his taste only in choosing food, and usually stops eating when hunger is satisfied. This is why a lower animal seldom has indiges-

tion. Man would be just as healthy if he would follow the same course; but because food tastes good, he overeats until the cells acquire the habit. Disease is the result. If our eating and drinking could be controlled, we should seldom be sick, and most of us would live many years longer.

One should scarcely know he has a stomach, so perfectly should it do its work. A simple food always tastes best and digests best. Highly flavored foods and complex foods usually defeat taste in its work of selecting foods. Then we eat too much. But if this principle is followed, taste and satisfied hunger are safe guides to both *what* and *how much* to eat. A deranged appetite usually originates in tempting the natural appetite with highly seasoned foods. Most desserts and pastry serve no other purpose than to make a false appetite and a grave form of indigestion. They are nearly always served after the appetite is already satisfied. A meal of only a few simple foods selected by taste and to satisfy hunger is always best.

2. Amount of Food. — The amount of food used is determined by (1) *age*, (2) *climate*, (3) *state of health*, (4) *occupation*, (5) *mental condition*, (6) *vitality*, (7) *habit*, (8) *sex*, (9) *amount of alcohol used*, and (10) *amount of oxygen inhaled*.

When growing, a person needs more tissue-making food, and in old age more heat-making food. A person requires about the same amount of food for the tissues in both winter and summer, but a greater amount of food for heat when it is cold. People who are sick nearly always require less food, and different food. One engaged in hard manual labor requires much more food than when engaged in mental labor. People in distress or sorrow do

not eat so much as when in a state of joy. The cells of active people use more nourishment and make more waste; for this reason, some people, however much they eat, can never get fat.

By habit, most people overeat. The large evening meal, which is to most people an injury, is a matter of habit. Females usually eat less than males, and really do not eat enough, nor with proper regularity. Regular drinkers require more food. One who is much in the open air eats more, because of increased oxidation. Since so many things modify the quantity of food used, it is difficult to make an accurate statement of the amount of food one should use in a given time, but the following is a statement based on averages: The average man will assimilate in a day about 4½ ounces of albumin, 4½ ounces of fat, 5 ounces of sugar or starch, and from 75 to 100 ounces of water, with a small amount of minerals. This amount is actually needed to repair waste and to make heat and energy. Most people eat much more, and many eat twice as much. In order to get the necessary food elements, a variety of food must be chosen, but the following may be taken as the proper quantity of the foods needed for one day: Bread, ½ pound, 2 eggs, 1 pound of meat, 1½ pints of milk, and 2 ounces of butter. If milk is used, eggs may be omitted, and less water taken. If other foods are added, then less of these should be used.

3. **Oxygen Needed.**—About twenty-four ounces of oxygen, on an average, is taken into the system in a day and night, a little more than one and two thirds as much as the solid food used. Albumin and sugar require about one and a half times their weight of oxygen, and fat about three times its own weight of oxygen. If more oxygen is taken into the lungs, then more food can be oxidized.

Vigorous exercise and deep breathing in the open air will overcome the results of overeating.

4. Quality of Foods. — There are four chief points in determining the quality of food: (1) proper proportion to make tissue and heat, (2) sufficient bulk, (3) variety, and (4) purity.

The elements for making heat and tissue must be adapted to the climate. More sugar, starch, and fats are needed in winter, and more acid, fruits, and vegetables in summer. If foods of too great bulk are eaten, the stomach and intestines are overworked; if not enough bulk, there is not work enough for them. It is necessary for a certain amount of waste to pass through the intestines to stimulate them to good work. A diet composed of both animal and vegetable foods, with vegetable foods in excess, is best. With the necessary amount of fat from butter and oils, a perfect diet of milk, eggs, and vegetables can be made, omitting meats altogether. Some of the best examples of physical strength and endurance are men who ate no meat at all; for example, the soldiers of Cæsar, the Japanese soldiers, and the savage Zulus in their long military marches. The food of the legions of Cæsar was wheat, of the Japanese, rice, and the Zulus, corn and milk.

5. Cooking. — Cooking produces at least the following results: (1) it makes food easier to digest, (2) develops flavor, (3) destroys parasites and disease germs, and (4) preserves nutrient elements.

Some foods, as fruit, eggs, milk, some vegetables, and oysters, may be eaten in a raw state; but most of these are better if cooked.

Cooking overcomes the connective tissue of meats, which enables the digestive fluids to enter, and do more effective work. Food is also more easily digested when warm.

Cooking brings out the flavors of foods, and makes them taste better, which causes the digestive fluids to flow more freely. Cooking destroys parasites, eggs, or germs of disease. Pork may contain the trichina, or small animal parasite; beef, mutton, or pork, the germs of tapeworms, and almost any food the germs of some disease, all of which are destroyed by heat. Cooking also preserves many nutrient juices, especially in meats, and thus makes the food more valuable. Heat also destroys fermentation.

All cooking should be thorough. Very rare meats are not so wholesome, and the half cooking of vegetables only toughens them.

6. Seasoning. — Habit has much to do with seasoning. There are many condiments and relishes that seem to develop the flavors of foods, or by their own flavor stimulate the appetite and cause digestive fluids to flow. Such spices as pepper, cloves, and nutmeg are favorites. The extracts of many fruits, as the lemon, make food more palatable. There can be no objection to a moderate use of any of these, but they are not foods, and injury will result from excessive use. One can get the pepper habit as well as the whisky habit. High seasoning, whether with condiments or fat, is a bad practice.

7. Hot and Cold Drinks. — The temperature of foods should not be far from that of the body. Warm foods are more easily digested, but they should never be warm enough to cause pain. Milk and water taste better below the temperature of the body, but should not be taken when ice-cold. Coffee, tea, and chocolate should be served warm. Persons of weak stomachs should drink warm water with their meals. Drinking ice water when one is overheated arrests digestion and has been known to cause death. Eating frozen fruits is dangerous.

OUTLINE SUMMARY

1. *Appetite.* 1. Hunger and thirst — indicate need of food.
   2. Taste — a desire for a particular food or drink.
   3. Strength — hunger and taste should be definite and strong.

2. *Amount of Food.* 1. Factors — age, climate, state of health, occupation, mental condition, habit, sex, and amount of oxygen.
   2. Items — about 4½ ounces of albumin, 4½ ounces fat, and 5 ounces of sugar; also about 100 ounces of water and some minerals.
   3. Model diet — make statement.

3. *Oxygen Needed.* 1. Total amount — about 24 ounces per day.
   2. Proportion — the more oxygen that is taken into the body, the more food will be required and oxidized.

4. *Quality.* 1. Things to be considered — proportion, bulk, variety, and purity.
   2. Seasonable foods — heat-making foods in winter, and tissue builders in summer.
   3. Perfect diet — proper proportion, and sufficient quantity.

5. *Cooking.* 1. Results — develops flavor, destroys parasites and germs, makes food more easily digested, and preserves nutrient elements.
   2. What to cook — most vegetables, and meat.
   3. Quality — should be thorough.

6. *Seasoning.* 1. Physiological effect — develops flavors, stimulates digestive fluids.
   2. Foods — some seasonings like butter, oils, and gravy used in serving are good; also spices and pepper, if used moderately.

7. *Hot and Cold Drinks.* 1. Degree — neither very hot nor very cold.
   2. Extremes — ice water or hot soup may cause serious illness.

QUESTIONS

1. Define *hunger* and *taste*. Is taste a reliable guide in choosing foods?
2. What amount of *food* and *oxygen* is needed in a day?
3. What is meant by "proportioning" foods?
4. What is the effect of cooking? Give examples.
5. What is the effect of seasoning foods? Of hot and cold drinks?

CHAPTER XVIII

HOW TO MAKE GOOD DIGESTION (*continued*)

1. Change Needed. — Some articles of food can be used nearly all the time, while others can be used but a few meals at a time. Such foods as milk, eggs, butter, bread, and potatoes may be used at almost every meal by many people, especially when the foods used with them are changed frequently. The reason for this is that these foods, each in its place, are almost perfect foods. But a large majority of foods and drinks are not perfect, and require frequent change. There must be a change in the articles and in the manner of serving. A food prepared in the same way soon becomes unpalatable. While a variety of food is essential, there should never be a great variety at a single meal, because the appetite will be unduly tempted. Three or four good foods, well adapted, well cooked, and well served, make the best meal. Good bread, milk, butter, one meat, potatoes, and some article containing sugar, make a good meal. The vegetable, meat, and sugar may be changed to others of the same kind, and the meal remain practically perfect; in fact, many people live almost entirely on one article of diet, as rice or bananas. This diet does not give the best growth or strength, but it proves that far too many foods are used by the average person. Great variety is the chief cause of much stomach trouble.

2. Overeating. — The immediate effect of overeating is the derangement of the digestive system. The glands are overworked and the quantity of the ferments is not sufficient; the stomach, liver, and intestines lose much of their

strength, and much of the food passes without any digestion at all. In slight but regular overeating the cells adapt themselves to the condition, and an unnatural appetite is acquired. A surplus of food gathers in the system, the strain weakens the nerves, the heart is affected, oxidation becomes less, and lung trouble may appear. In the end nature rebels, and a general breakdown follows.

About an ounce and two thirds of oxygen is required to every ounce of solid food. This proportion cannot be disturbed without loss of health in some form. If the lungs take in more oxygen than is needed, one will eat heartily, but remain thin; he will overwork his stomach, and serious gastric disorders follow. Another person may have exactly the opposite condition. His stomach being strong, he digests too much food for the amount of oxygen the lungs can supply. He is inclined to eat less, but to grow fat, and overtax the lungs. Lung disorders follow. These two difficulties can be overcome by having the former eat foods more easily digested, and the latter eat foods more difficult to digest; or the errors may be corrected by physical exercise.

3. **Regular Meals.** — Eating at a given time becomes a habit. The stomach can act better at the time set by habit. Hunger will appear at that time, taste is much better, and enjoyment greater. All this is essential to good digestion. If hunger is not satisfied at the proper time, it will disappear.

The digestive organs must have considerable time for rest. One should never eat between meals, because it does not give the digestive organs the needed rest; it creates a sort of secondary appetite and weakens the regular appetite at mealtime.

4. How to Eat. — In order that eating be properly done, there are four necessary conditions: (1) thorough mastication, (2) a relaxed mind, (3) happiness, and (4) good companions.

If mastication is slow and thorough, the glands are given time to supply the ferments, and the mixing is well done. The effect of the mind is such that if one thinks hard while eating, too much energy is taken from the digestive organs. If the feelings are disturbed, as in sorrow or great anxiety, the digestive glands do not act properly, and the fluids are deficient. Good companions satisfy the social nature.

5. Drink at Meals. — It is well to drink something at meals. What to drink, and how much, are important questions. Milk may be taken slowly, along with other food; a small amount of water may be taken in the same way. The objects of drink at meals are to soften solid foods and give a needed relish. Such a drink as grape juice may be taken with other food. Coffee and tea, if used at all, should be taken at the same time as the foods, and drunk slowly. No alcohol, even in very weak forms, can be taken at or immediately after meals without injury. Very small quantities of alcohol, diluted, may stimulate a weak stomach, but if used regularly, will injure it. If used at all, alcohol should be taken before the meal.

6. Effects of Alcohol on Digestion. — Alcohol is a drug, and not a food. It is therefore not good for healthy persons, but like many other drugs, has been used for medical purposes. Alcohol should not be so used and should not be prescribed. Even when taken in very weak form and in small quantities, it may lead to the alcohol habit. Alcohol stimulates the nerves and makes one feel better temporarily; but this effect is followed by a period

of depression, which injures digestion. It seems to make animal heat, but its use is followed by a period of low temperature and chilly sensations. If strong, alcohol extracts the water from the mucous membrane of the tract, causing unnatural thirst. It coagulates albumin, and prevents the gastric juice from acting on it. Alcohol congests the blood vessels of the stomach and irritates the mucous membrane. One of its worst effects is its action on the liver, producing what is known as the "whisky liver," which is very difficult to cure. Alcohol permanently injures the digestive system, attacks the brain, and poisons the entire system.

In its place, alcohol is a useful drug, but out of its place it is one of the most destructive drugs known.

7. Tobacco and Digestion. — The poison in tobacco is called *nicotine*, a clear, colorless liquid. It is so strong that a very few drops will kill a person. When first introduced into the system, it causes nausea. The sickness from the first chew of tobacco, or the first cigar, will never be forgotten.

It is a narcotic, and produces a relaxed, restful feeling, and seems to benumb and quiet the nerves. It stimulates and weakens the salivary glands. By acting on the nerves, tobacco is very hurtful to digestion and circulation. Nicotine weakens the cells of the entire body, and is especially hurtful to the heart, producing what is called the "tobacco heart." It injures the lungs, the brain, and most of the special senses. It affects digestion indirectly in all these ways.

The cigarette is usually the most injurious form of tobacco. It would not be so if made of good tobacco, and that only; but it is usually made of refuse tobacco; to this is added a drug for flavoring, and sometimes opium.

The flavoring drug is so strong as to color the lips, and the opium produces a drowsy feeling and a craving for another cigarette. Tobacco itself is very injurious to the young. The cigarette, when made of pure tobacco, is hurtful enough, but with other drugs added, it is a deadly thing. It will soon break down the digestion, affect the circulation, poison the brain, and cloud the mind. The evil effects of the cigarette are increased by inhaling the smoke.

The use of tobacco produces a drug habit. It is a strong one, and few men are able to break it. The best way to break it is to reverse the process by which it was made. Decrease the amount used slowly and steadily, until it is discontinued altogether. This is better than to take a "tobacco cure." A strong will and gradual decrease of the quantity used will break the habit. If this cannot be done, the victim should be treated for it.

Tobacco and alcohol aid each other. The excessive use of alcohol produces nervousness, which the soothing effect of tobacco overcomes. Tobacco produees thirst by exhausting the saliva, which is satisfied by the use of alcohol. The use of either seems to demand the use of the other, but either one is bad enough when it may destroy life.

8. Bad Teeth and Digestion.—If properly cared for, the tooth should be the last organ of the body to decay. The decay of teeth almost always comes from neglect and abuse.

Teeth should stand erect and fit well. The dentist can render valuable aid in this. One should remember where the big salivary ducts pour out saliva in the mouth, as teeth near these are more exposed and liable to decay. Saliva takes from the blood a substance called tartar,

and deposits it on the teeth, and between the teeth and gums. The little grains of tartar are very fine, but in the act of chewing they irritate the gum, cause it to recede from the tooth and ulcerate. This extends farther and farther toward the root of the tooth, unless cured. The tooth becomes loose finally, and has to be removed. This can be prevented, if the teeth are properly cleaned. The thin layer of tartar should be removed each day as it accumulates, and the gums made hard and adherent to the tooth. Besides washing the teeth three times a day with a soft brush, warm water, and mild soap, some good antiseptic mouth wash should be used. To keep the teeth white, a little corn meal or powdered charcoal may be used on the brush occasionally.

The enamel of the tooth should never be permitted to wear thin or break. Particles of food ferment, producing an acid which is injurious. This can be prevented by keeping the teeth clean. The enamel may be cracked by cutting thread, tearing cloth, breaking nuts or hard candy, or by hot or cold foods. Hot biscuit and ice water are hard on the teeth. When the enamel is once broken, decay cannot be prevented except by filling. Even when a cavity is formed, the tooth should not be extracted; it can be filled. Even if the decay is so great as to expose the nerve and produce toothache, have a dentist save the tooth if possible; it is better than an artificial tooth. Use toothpicks very little, only enough to remove particles of food. A toothpick tends to separate the gum from the tooth; a quill pick is best. Splinters from wooden picks may find their way to the stomach and intestines, and cause trouble. Never use a metallic pick. It is a good habit to call on a dentist or physician every few months, and have him look the teeth over, even when it is not known that there is anything wrong. This practice saves many

a person from years of distress. When there is an odor of any kind from the teeth, they should be examined.

OUTLINE SUMMARY

1. *Change Needed.* 1. Staple foods — only perfect foods can be used continuously.
   2. Items — three or four good foods make a perfect meal.
   3. Variety — just enough to get elements of perfect food.
2. *Overeating.* 1. Effect — derangement of system.
   2. Oxygen and food — about one and two thirds ounces of oxygen to one ounce of solid food.
3. *Regular Meals.* 1. Habit — regulates hunger and taste; digestion is best when we eat at regular times.
   2. Rest — no one should eat between meals.
4. *How to Eat.* 1. Speed — eat very slowly; enjoy a morsel as long as possible.
   2. Conditions — thorough mastication, relaxed mind, tranquil feelings, good companions.
5. *Drink at Meals.* 1. Quantity — take very little; drink very slowly.
   2. What drinks — a small amount of milk, coffee, tea, water, or grape juice may be taken while eating.
   3. Alcohol — a small amount of diluted alcohol may be taken before a meal, but if kept up, will injure the stomach.
6. *Alcohol and Digestion.* 1. Medicinal use — a temporary stimulant for stomach and nerves; if used often, will injure digestion.
   2. Effects — mild liquor stimulates, but period of depression follows. Make statement.
7. *Tobacco and Digestion.* 1. Poison — nicotine, a clear, colorless liquid; deadly poison.
   2. Effects — stimulates and weakens salivary glands, weakens nerves, weakens cells; the cigarette is especially hurtful to digestion.
   3. Habit — a drug habit, but can be broken up.
8. *Bad Teeth and Digestion.* 1. Decay — bad teeth impair digestion.
   2. Fermentation — loose particles of food ferment on teeth.
   3. Ulceration — a diseased mouth furnishes bacteria.
   4. Toothpicks — splinters may descend to the stomach.
   5. Odors — any odors from the teeth indicate a bad condition.

QUESTIONS

1. Why is a change of food sometimes needed?
2. What are the effects of *overeating*, and *irregular meals*?
3. How should one eat? What drinks should be taken at meals?
4. What are the effects of alcohol on digestion? Tobacco?
5. What effect have bad teeth on digestion? How can one keep good teeth and a clean mouth?

CHAPTER XIX

HOW TO MAKE GOOD DIGESTION (*concluded*)

1. Predigested Foods. — The chemist can put any ordinary food in almost the form found at any given stage of digestion. Starch can be ground or shredded and mixed with a substance like saliva; then it corresponds to food chewed and ready for digestion. Albumin can be cut up into very small particles and mixed with pepsin, and thus put into almost the same condition as when it is ready to leave the stomach. Fats are made ready for the duodenum. Such foods are called predigested foods.

2. Medicine and Digestion. — If any part of the process of digestion is not normal, medicine may be used to correct it. If the ferments are poor in quality, suitable digestants must be used until the ferments can be restored. If the quantity is not sufficient, then medicines to act on the glands must be used. The saliva, stomach contents, and fluids of the duodenum can be analyzed, and the actual needs found. Then a physician can give a remedy that will correct the condition. In the same way, needed foods may be determined.

Strong medicines should not be used except upon the advice of a physician. Overeating and the use of alcohol are the chief causes of dyspepsia. Most people can cure it without the use of drugs, if they will remove the cause, and diet to suit the conditions. Nature's forces are sufficient to do the work, if normal, and medicine should be used only to help nature.

Some people have a weakness for certain medicines. The use of patent medicine is one of the greatest evils in

the whole field of hygiene; sometimes these medicines do good, but they are usually so general that they cannot reach a given case; besides, many of them are frauds of the worst sort. In case of excessive pain from indigestion, an opiate should never be given except by a physician.

3. Appearance of Foods. — To be palatable, foods must look well, and have a good odor; this is especially true of meat and sea foods. All food must be clean, wholesome, and attractive. Foods also must be daintily served; table linen must be clean and of good quality, cutlery and china clean and attractive, and the surroundings suggestive of comfort and good cheer. The dining room should be the most cheerful and beautiful room of the house. The meal should be, as far as possible, a happy social occasion.

Lunches for school, office, car, or outing party should be very carefully and daintily prepared. Napkins should be clean, and the lunch protected against infection. Children should not be permitted to buy cheap lunches from street venders or at unsanitary shops.

4. The Mind and Digestion. — It is well known that the state of mind affects digestion. Joy tends to relax the system and open the glands. Sorrow has the opposite effect. Fright and anger are powerful agents in disturbing digestion. This is called the *psychic factor* in digestion. It plays an important part in all vital processes, in functional disorders, and in many diseases. Sometimes the best effect of the water of mineral springs is the psychic effect, and frequently it is the only effect. One cannot think an infection, as measles, out of the body; when it is really there, it must run its course; but the mind, by affecting digestion and repair, may influence the progress of some diseases.

5. **Fermentation of Foods.** — Most sudden deaths attributed to heart failure are due to trouble in the stomach, and not to the heart. The connection between the stomach, heart, and brain is so intimate that one of them cannot be in trouble without affecting the others. A bad stomach usually makes a bad heart and a bad head. This is seen in the case of fermentation of foods. Germs are taken in with the food; if gastric juice is good, it kills them in the stomach; otherwise the germs multiply, and produce fermentation, or sour food, and some acids and gas are the result. We speak of it as a "sour stomach." The gas, or wind, as it is called, distends the stomach, and makes one feel very uncomfortable. If it is not relieved by medicine, or by vomiting, it may cause severe pain, and lead to disease.

6. **Taste as a Guide.** — In a state of health, taste is a reliable guide so long as we eat plain foods seasoned simply, and taken in reasonable quantities. If a person eats only plain food, and stops eating as soon as the appetite is satisfied, there will be no trouble about his digestion. But when he goes beyond this, tempts his appetite with highly seasoned foods, and indulges in fancy dishes and wines, the appetite becomes the victim of habit and dissipation, and taste ceases to be a good guide. Plain foods alone, used in moderation, can make health.

7. **Rest a Factor.** — It is not easy to digest a meal when one is tired, as fatigue involves the nerves. It is a good plan to rest for a short time before a meal is taken. If convenient, a glass of warm water or milk, and a short sleep before a meal, when one is very tired, will make digestion easy. Many a sleepless night is due to eating a large meal when the body is tired and spirits depressed. After a meal, the stomach must have more blood and en-

ergy, and to get them, a short rest should be taken. The stomach must have time to begin well the digestion of a meal before any heavy work is undertaken.

8. **Rules of Digestion.** — (1) Do not eat food until it is well prepared and properly served. (2) Chew slowly, grind the food thoroughly, and swallow before taking more. (3) Stop eating as soon as the appetite begins to feel satisfied. (4) Always let about six hours elapse between meals. (5) Never eat until a feeling of hunger appears. (6) In case of temporary indigestion, take an extra amount of physical exercise. (7) Mix coarse and fine foods, as it is essential for the intestines to have considerable work at the proper time. (8) Attend promptly and regularly to the excretions. (9) See that the proper amount of sleep is had every night, if possible. (10) Take neither stimulants nor narcotics, except when they have been prescribed by a physician.

9. **The Number of Meals.** — Three meals a day are sufficient for adults, although many persons eat four or five times. Frequent eaters are not people of long life. Frequent eating has the same effect as overeating, with the addition of giving the stomach almost continuous work. People who do hard manual labor should take meals about six o'clock in the morning, at noon, and at six in the evening. Those engaged in mental labor should not eat so much nor so often. A good plan for a mental worker, or person of sedentary habits, is to eat a good breakfast about 7 A.M., a dinner at 2 P.M., and nothing at night except some fruit or some bread and milk. Another good plan for mental workers who have heavy work in the afternoon is to eat a good breakfast about 7 A.M., a light lunch at 1 P.M., taking some light exercise in the open air after lunch; then eat a good

dinner about 5 P.M., always resting a full hour after dinner, and taking some light physical exercise before beginning work or meeting a social engagement at night.

10. Time required for Digestion. — The amount of time and energy required to digest a given food is as important as the amount of energy it will produce. This knowledge aids us in selecting foods. Time and energy for a given food depend upon several things, as quality of food, season, occupation, and vitality of person. For an average person, and a good quality of common food and drinks, the following is about the time required for digestion: —

DIGESTIBILITY OF FOODS

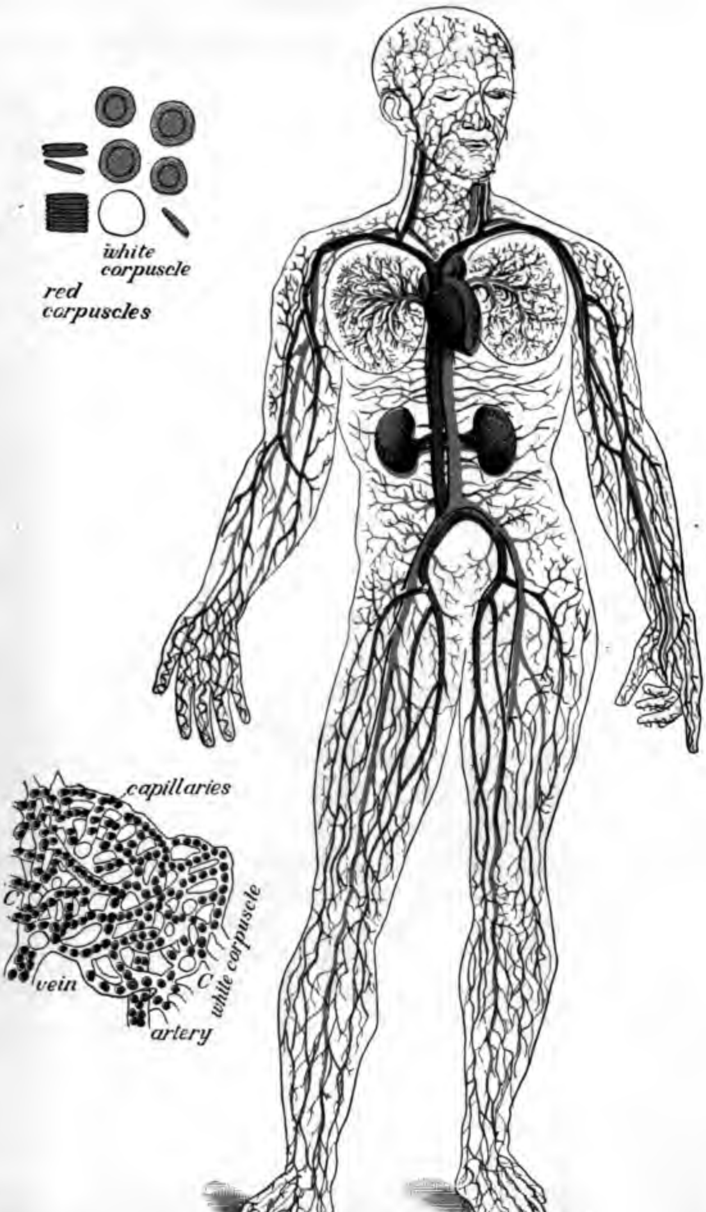
Article	Form	Time for Digestion
Apples	Cooked	1 to 2 hours
Beans	Boiled	2½ hours
Beef	Lean, roasted or broiled	2½ hours
Beef	Well done, fried	3 hours
Beets	Boiled	2 to 4 hours
Bread	Wheat, corn, baked	3 to 3½ hours
Cabbage	Boiled	4 hours
Cheese	Raw	3½ hours
Chicken	Fried, boiled, roasted	3 to 4 hours
Duck	Roasted	4 hours
Eggs	Whipped, raw	1½ to 2 hours
Eggs	Soft boiled	3 hours
Eggs	Hard boiled or fried	3½ hours
Fish	Boiled or fried, fresh	1½ hours
Goose	Roasted	2½ hours
Liver	Broiled	2 hours
Mutton	Broiled	3 hours
Oysters	Cooked	3½ hours
Oysters	Raw	3 hours
Parsnips	Boiled	2½ hours
Pork	Roasted	5¼ hours
Pork	Pig, roasted	2½ hours
Pork	Fried	4½ hours
Potatoes	Boiled	3½ hours
Rice	Boiled	1 hour
Turnips	Boiled	3½ hours
Turkey	Boiled	3½ hours
Veal	Broiled	4 hours

OUTLINE SUMMARY

1. *Predigested Foods.* 1. Definition — foods altered by chemical action to correspond to food in different steps of digestion.
   2. Value — very useful in certain states of illness.
2. *Medicine and Digestion.* 1. Need — to correct an error or supply a deficiency in digestion.
   2. Abuse — makes nerve cells lazy; leads to medicine habit.
3. *Appearance of Food.* 1. Looks — must look well, have no unpleasant odors.
   2. Dining room — the most cheerful room in the house.
4. *The Mind and Digestion.* 1. The psychic factor — the state of the mind affects digestion.
   2. Vital action — the mind affects the vital processes.
5. *Fermentation of Foods.* 1. Vital connections — stomach, heart, and brain intimately connected.
   2. A "sour stomach" — due to fermentation, germs taken in mouth.
6. *Taste as a Guide.* 1. A good guide — when only plain foods are eaten.
   2. A bad guide — ceases to be a reliable guide when perverted by bad foods and gluttony.
7. *Rest a Factor.* 1. Nerves — tired nerves affect digestion.
   2. Energy — after a meal the energy of the body is needed for digestion; a short rest is very helpful.
8. *Rules of Digestion.* 1. Number — at least ten good rules — state them.
   2. Observance — follow rules, and there will be no indigestion.
9. *Number of Meals.* 1. For manual laborers — three meals a day, six hours apart.
   2. For brain workers — two meals a day, seven hours apart, and light lunch at night; no meats or other gross foods at night.
10. *Time required for Digestion.* 1. Depends — upon quality of food, season, occupation, and strength of person eating.
    2. Amount — state time for common foods.

QUESTIONS

1. How do medicines aid digestion? Predigested foods?
2. What effect does the appearance of foods have on digestion? How does the mind affect digestion?
3. What is the fermentation of foods? What causes a sour stomach and "heartburn"?
4. How many meals should one eat, and at what hours each day?
5. What time is required for digesting ordinary foods? Give examples. What are some good rules for digestion?


white corpuscle
red corpuscles
capillaries
C
vein
C
white corpuscle
artery

CHAPTER XX

THE HEART AND BLOOD VESSELS

1. General Description. — The circulatory system is composed of the heart and blood vessels. The heart is a powerful muscle about the size of one's fist, and acts as a pump to send the blood to all parts of the system, and to receive it again on its return. By means of the heart and blood vessels, the food, in a digested state, is sent to every cell in the body. Arteries carry food and oxygen, and veins carry away waste material.

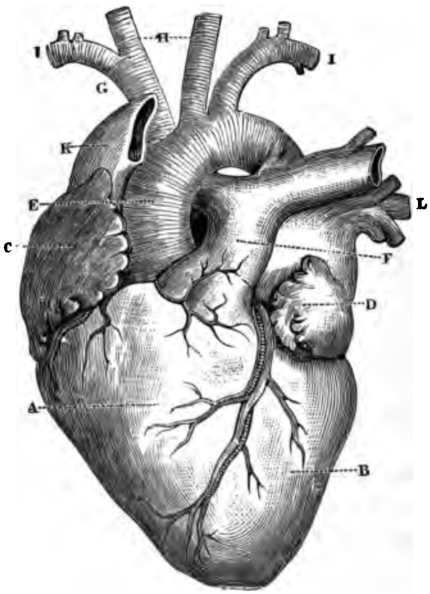


Fig. 32. — The heart.

A, the right ventricle; *B*, the left ventricle; *C*, the right auricle; *D*, the left auricle.

2. Location. — The heart is located a little to the left of the median line of the body, between the lungs. The upper end points a little backward, and to the right; the lower end, therefore, points forward and to the left. The upper end is larger than the lower end. The fingers can locate the heart by its pulsation, or beat; the ear can locate it by its sounds.

3. Size. — The heart of an average adult is about 5 inches long, $3\frac{1}{2}$ inches wide, and $2\frac{1}{2}$ inches thick; it weighs from a half to three fourths of a pound. The heart is somewhat pear-shaped, or cone-shaped, with its apex pointing downward, its base convex, and body slightly flattened. It is a little larger in the male than in the female, and holds about a pint of blood, when full.

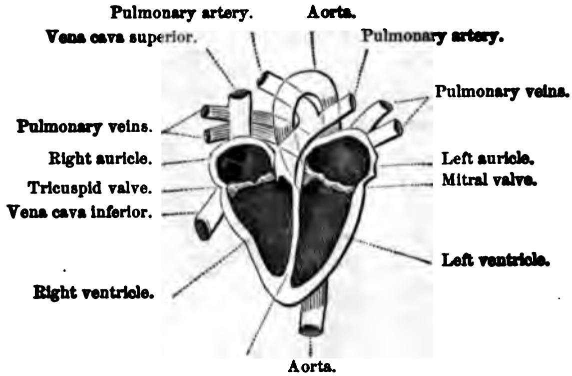


Fig. 33. — Representation of a section of the heart (diagrammatic).

4. Parts. — There are three parts of the heart, the ***pericardium***, the *endocardium*, and the *cardiac muscle*. The pericardium is a serous membrane which incloses the heart like a bag; it secretes a fluid which enables it to glide smoothly against the outer surface of the heart. The inside of the heart is lined with another serous membrane, which is continuous with the inner coat of the blood vessels, and called the endocardium. Between the two we find the heart proper, the cardiac muscle, which is composed of a series of interlaced muscular fibers. These muscular fibers make the motions of the heart. The pericardium is attached at one point to the diaphragm. There is almost fluid enough within the pericardium to

float the heart, thus giving great freedom of motion. The heart is firmly attached to the large blood vessels from which it hangs.

5. Cavities. — The two sides of the heart are really two hearts, sometimes called the right and left heart. They are separated by a strong membrane without valves. The right heart receives blood from all parts of the system and sends it to the lungs to be purified, while the left heart receives blood from the lungs and sends it to all parts of the body. Each side of the heart is divided into two chambers, the upper one being called the auricle, and the lower the ventricle. The two auricles receive blood, one from the body, and the other from the lungs; the two ventricles pump the blood out, one to the lungs, and the other to the body.

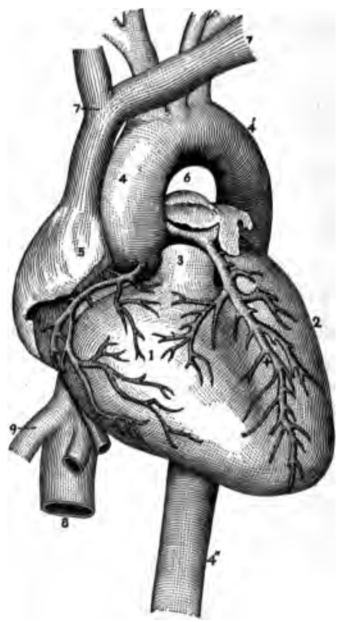


FIG. 34. — The heart and large blood vessels, in front.

1, right ventricle; 2, left ventricle; 3, pulmonary artery, cut short; 4, 4', 4", aorta, or chief artery; 5, 6, parts of the right and left auricle; 7, 7, veins uniting to form the superior (upper) vena cava; 8, inferior vena cava; 9, vein from liver; +, arteries nourishing the heart.

6. Valves. — There are five valves in the right heart, four in the right auricle, three in the openings of veins that enter the auricle, and one between the auricle and the right ventricle. Besides the valve opening from the right auricle, the right ventricle has only one valve, which is at the opening of the

artery leading to the lungs. The left heart has six valves; the auricle has entering it from the lungs four veins, each of which has a valve; the left auricle has also the large valve opening into the left ventricle. The left ventricle, besides the valve opening from the left auricle, has only one valve, which is at the mouth of the aorta, the great artery carrying blood to all parts of the body. The heart has in all eleven valves.

7. **The Right Auricle.** — The right auricle receives blood from three large veins, the *superior vena cava* bringing blood from the upper part of the body, the *inferior vena cava* bringing blood from the lower part of the body, and the *coronary vein* bringing blood from the walls of the heart. The right auricle receives only impure blood, all the impure blood of the body passing through it. It is a little larger than the left auricle.

8. **The Right Ventricle.** — The right ventricle receives blood from the right auricle, and sends it to the lungs; there is in the wall between the right auricle and ventricle a valve called the tricuspid, because it has three points. This valve prevents the backward flow of blood when the ventricle contracts to send the blood to the lungs. The right ventricle has another valve at the mouth of the pulmonary artery, called the *semilunar*, because of a half-moon shape. The valve opens into the artery, allowing the blood to pass when the ventricle contracts, then closes, preventing any backward flow into the ventricle.

9. **The Left Auricle.** — This auricle receives only blood from the lungs. The blood enters by the four pulmonary veins, the valves of which take the names of the veins.

10. **The Left Ventricle.** — The left ventricle receives blood from the left auricle, and sends it to all parts of the

body. The valve between the left auricle and ventricle, called the bicuspid, or mitral valve, prevents the backward flow of the blood when the left ventricle contracts. The valve at the mouth of the aorta is known as the semilunar, and is similar to the one in the right ventricle. The walls of the left ventricle are thick and strong because of the hard work they do. It is the powerful contraction of this ventricle that is felt as the heavy heart beat.

11. **Motions of the Heart.** — As the auricles contract, the ventricles expand to receive the blood. As the auricles expand, they receive blood from the veins, the right from the veins of the body, and the left from veins of the lungs. As the ventricles contract, they force blood into the arteries, the right into the pulmonary artery, and the left into the aorta for the body. The contraction of the heart to force the blood into the arteries is called *systole*, and the expansion to receive blood is called *diastole*. The heart beats in a healthy adult about 72 times a minute. The pulse is much faster in infants, and in the aged it is usually slower. It varies with the time of day, with states of disease, with the state of the mind, and before and after meals. Indigestion, excitement, and mental strain run the pulse up. It has been known to go as low as 22, and as high as 156 in the same patient.

12. **Blood and Nerves.** — The heart has a blood supply and a nerve supply of its own. The heart's action is regulated by two sets of nerves, one from the brain, and one from the spinal cord.

13. **Sounds.** — There are two distinct sounds of the heart, one louder than the other. The dull sounds are made by contraction of the ventricles, and the sharp sound is made by the closing of the semilunar valves after the blood has been forced into the arteries. Between the two

sounds there should be a short period of silence. There are also two distinct beats of the pulse, one stronger than the other.

14. Diseases. — Palpitation is usually due to indigestion, overexertion, or excitement. A very common heart disease is known as "fatty heart." Fat is deposited in some of the cells of the heart. Another serious heart disease is valvular trouble; the valves thicken and do not fit, allowing some of the blood to flow backward. In these diseases, if the patient will not exert himself too much, the heart may do good work for many years. Fainting is due to partial, temporary heart failure, not enough blood being sent to the brain; usually this is not serious. The "tobacco heart" and "whisky heart" are two well-known heart diseases, due to poison. A bad case of indigestion may cause death through the influence of the stomach on the heart. Shock also causes the heart to stop beating sometimes.

OUTLINE SUMMARY

1. *General Description.* 1. Vessels — heart, arteries, capillaries, and veins.
   2. Work — to carry food to tissues, and waste material away.
2. *Location of Heart.* 1. Relative place — between lungs, a little to left of median line.
   2. Inclination — upper end points to the right and backward.
3. *Size.* 1. Dimensions — about 5 in. long, $3\frac{1}{2}$ in. wide, $2\frac{1}{2}$ in. thick.
   2. Capacity — about a pint.
4. *Parts.* 1. Names — pericardium, endocardium, and cardiac muscle.
   2. Attachments — to great blood vessels.
5. *Cavities.* 1. Two hearts — left and right; no direct communication.
   2. Chambers — each side has two, auricle and ventricle.
   3. Work — auricles receive blood, and ventricles discharge it.
6. *Valves.* 1. Number — right heart has five valves, and left heart has six.
   2. Use — prevent the backward flow of the blood.

7. *Right Auricle.* 1. Veins — three, *superior vena cava*, *inferior vena cava*, and *coronary*.
   2. Valves — at opening of each vein, and named for vein.
   3. Work — to receive impure blood from all parts of body.
8. *Right Ventricle.* 1. Valves — two, the tricuspid and semilunar.
   2. Work — to send blood to the lungs.
9. *The Left Auricle.* 1. Veins — four veins from lungs, each having a valve.
   2. Work — to receive blood from lungs, send to ventricle.
10. *The Left Ventricle.* 1. Valves — two, the mitral, or bicuspid, and semilunar.
    2. Work — to send blood to the tissue.
    3. Walls — thick and strong.
11. *Motions.* 1. Number — two, systole and diastole.
    2. Rate — 72 times a minute, but it varies.
12. *Nerves.* 1. Vessels — heart has a set of blood vessels of its own.
    2. Nerves — two sets, one from brain, and one from spinal cord.
13. *Sounds.* 1. Number — two, one louder than the other; also two distinct beats, one stronger than the other.
    2. Cause — the dull sound made by contraction of ventricles, and sharp sound made by closing of semilunar valves.
14. *Affections.* 1. Disorders — weak heart and palpitation, caused chiefly by indigestion.
    2. Diseases — "fatty heart," valvular disease, heart failure, "tobacco heart," and "whisky heart."

QUESTIONS

1. What are the general divisions of the circulatory system?
2. Give the location, size, and parts of the heart.
3. Describe the *cavities* and *valves* of the heart.
4. What are the *motions* and *sounds* of the heart?
5. What are some of the diseases of the heart?

CHAPTER XXI

THE BLOOD VESSELS

1. General Description. — The blood is conveyed to the tissues, and waste material removed by a system of tubes or vessels called blood vessels. They are divided into three general classes, called *arteries*, *veins*, and *capillaries*. These differ in structure, location, and use. Arteries carry

blood from the heart to the cells, and with one exception carry pure blood. The veins carry blood from the cells to the heart, and with one exception carry impure blood. The capillaries are very fine tubes that connect the veins and arteries ; they receive food and give it to the cells ; also take up waste matter and turn it over to the veins to be carried away.

2. The Arteries. — Arteries usually lie deep near the bones ; when near the surface, they are usually protected against cuts, burns, and bruises. In branching, arteries usually separate at a small angle, which aids the flow of blood. Branches from a given trunk frequently reunite and become a network of small arteries. By this means blood may reach a given tissue by more than one route. This is called *anastomosis.*

3. The Aorta. — This is to all other arteries what the trunk is to the tree ; they are all branches of the aorta. This trunk begins at the left ventricle, makes a great arch upward, backward, and a little toward the left ; it then takes its course downward with the spinal column, occupying a place on the left side of that organ. Near the fourth lumbar vertebra, it divides into two branches. Several branches of the main trunk are given off to supply the head, trunk, and the organs of the thorax and abdomen. This artery is about an inch in diameter. The branches of the aorta penetrate all tissues in the body except such as nails, hair, cartilage, the cornea, and the outer skin.

4. Names of Principal Arteries. — Arteries are so distributed that almost any region may be supplied with blood from two different arteries, usually from different directions. If one artery is injured, the blood supply may be borrowed from another. This is called a *collateral circulation.* The arch of the aorta gives off five branches;

two are the right and left *coronary*, and supply the walls of the heart; the other three are the *innominate*, *left carotid*, and *left subclavian*. The innominate soon subdivides, making the *right carotid* and the *right subclavian;* the carotids supply the head, one on the right and the other on the left. Each carotid has an internal and an external branch, the internal supplying the brain, and external supplying the face and scalp. The subclavian arteries supply the shoulders, arms, and a part of the chest; they take the name *axillary*, under the arm, and *brachial*, in the upper arm; they divide into the *radial* and *ulnar* in the forearm. It is the radial artery that doctors feel when taking the pulse.

The main divisions of the great aorta are called the *common iliacs*, which are very short arteries, only about two inches long. Each iliac divides into the internal and external. On both sides of the body the external iliac sends its branches to the organs within the pelvis, the walls of the pelvis, and the inner thigh; the external iliac passes down through the inner thigh, where it is called the *femoral artery;* lower down, behind the knee, it is called the *popliteal;* below the knee it divides into the anterior and posterior *tibial* arteries.

The great aorta, at the margin of the diaphragm, gives off a branch which divides into the *gastric*, the *hepatic*, and the *splenic* arteries, supplying the stomach, the liver, and the spleen. A little lower the aorta gives off the superior and inferior *mesenteries*, which supply the intestines.

5. Structure of Arteries. — Arteries have three coats. The inner coat is serous; the middle coat is fibrous, composed of muscular and elastic fibers; the outer coat is cellular, with elastic fibers of connective tissue. The outer is the strongest coat of the arteries; it is so strong that it makes the artery stand open when not filled. The middle coat,

being muscular, makes arteries elastic, and gives them the power to contract. The inner coat is very smooth. Arteries have no valves except those belonging to the heart. Because arteries stand open after death, they were thought for many centuries to contain air and to be connected with the lungs. An English physician named Harvey discovered the circulation of the blood as late as 1628 A.D.

6. Veins. — Veins differ in several important particulars from arteries. Veins carry blood toward the heart, lie nearer the surface usually, branch at larger angles, and contain valves. The flow of blood in veins is constant. Veins are more numerous and weaker than arteries, and collapse when empty; they are divided into three classes, called the *superficial*, *deep-seated*, and *sinuses*. The superficial veins lie near the surface, and include the majority of the veins. Deep-seated veins are those that run along with arteries. They are usually inclosed in the same sheath with an artery and a nerve; the sinuses are within the cranium between layers of the *dura mater*, a covering of the brain.

7. Structure of the Veins. — Veins have three coats: the inner, a serous membrane, the middle muscular, and the outer, composed of connective tissue. The middle or muscular coat is not very strong; the outer coat also is weaker than the outer coat of arteries. Veins are provided with valves made of folds of the serous and muscular coats of the veins; they are semilunar in form, and permit the blood to flow freely toward the heart, and prevent its flow in the opposite direction. Veins branch and reunite, as arteries do. The superficial veins may be

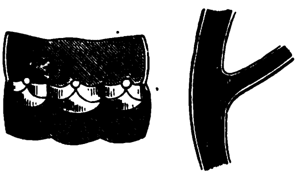


FIG. 35. — Valves of the veins.

seen through the skin; they stand out like cords, and usually have a dark color, especially in the aged.

8. Names of Principal Veins. — The *superior vena cava* is the large vein that carries the blood from the upper part of the body to the heart, while the *inferior vena cava* carries blood from the lower part of the body. The principal deep-seated veins have the same general course and names as the large arteries, but their blood flows in the opposite direction. The *gastric vein*, the *splenic vein*, and the superior and inferior *mesenteric* veins, which collect the blood from the stomach, spleen, and intestines, unite to form the *portal vein*, which carries this blood to the liver. The *hepatic veins* take up the blood after it passes through the liver, and carry it to the *inferior vena cava*. There are four *pulmonary veins* that convey the blood from the lungs to the left auricle. As arteries convey blood to almost every cell in the body, and are found everywhere, so veins must receive the blood as soon as it has delivered its load of oxygen and food, and taken up a load of waste material; they, too, are found almost everywhere in the body.

9. Capillaries. — Both arteries and veins subdivide until they are smaller than a fine hair, but the arteries and veins are connected by much smaller tubes, found in every tissue to which the blood goes; they are so small that they find their way between the cells, and sometimes touch the cells. Their walls are a thin membrane which is a continuation of the inner membrane of the arteries. Both gases and liquids pass freely through the walls of the capillaries. The beautiful red tint of healthy skin and nails comes from the blood in the capillaries; when it is pressed out, the skin is white; the pallor of death appears when the blood leaves the capillaries. The blood never stands still

in the capillaries. When blood enters the capillaries, it has a bright red color, and on leaving them it is much darker. It has given up food and gathered up waste. The liquid part of the blood has passed through the walls of the capillaries to the cells.

OUTLINE SUMMARY

1. *General Description.* 1. Classes — arteries, veins, and capillaries. 2. Differences — differ in location, structure, and use.
2. *The Arteries.* 1. Peculiarities — position, branching, and uniting. 2. Anastomosis — reuniting of blood vessels.
3. *Aorta.* 1. Trunk — the great trunk of the arterial system.
   2. Location — besides arch, it lies to left of spinal column.
   3. Branches — near the fourth lumbar vertebræ; iliacs.
   4. Size — nearly an inch in diameter.
4. *Principal Arteries.* 1. Collateral circulation — arterial supply from unusual source.
   2. Names — named from appearance or position. Make statement of names.
5. *Structure of Arteries.* 1. Coats — three, the inner serous, the middle muscular, and outer cellular.
   2. Valves — none except those belonging to the heart.
6. *Veins.* 1. Differences — see § 6.
   2. Classes — superficial, deep-seated, and sinuses.
   3. Anastomosis — they separate and reunite like arteries.
7. *Structure of Veins.* 1. Coats — three, inner serous, middle muscular, and outer connective tissue.
   2. Valves — many valves to prevent the backward flow.
8. *Principal Veins.* 1. Names — named from location, appearance, and use. Make statement.
   2. Vena comites — deep veins accompanying deep arteries.
9. *Capillaries.* 1. Definition — hairlike tubes.
   2. Size — very small, from $\frac{1}{2000}$ to $\frac{1}{3000}$ of inch in diameter and $\frac{1}{50}$ to $\frac{1}{100}$ of inch in length.
   3. Use — to receive nutriment from the blood and convey it to the cells; and take up waste materials, and give it to the blood.
   4. Walls — a continuation of the inner membrane of the arteries; fluids and gases pass through walls of capillaries.

QUESTIONS

1. What are the differences between the *veins* and *arteries?*
2. Compare the *aorta* and *inferior vena cava.*

3. What is *anastomosis*?
4. Describe the aorta.
5. Describe the capillaries.
6. What change takes place in the blood in the capillaries?

CHAPTER XXII

THE BLOOD

1. The Blood. — Blood is a fluid which circulates through the blood vessels. The quantity varies, but is usually from $\frac{1}{14}$ to $\frac{1}{12}$ of the weight of the body, or from six to eight quarts. Arterial blood has a dark red color, a salty taste, and an odor somewhat like the breath of the animal from which it is taken.

Blood has two parts, a liquid part called plasma, and some little cells or bodies floating in the liquid, called corpuscles. Corpuscles are of two chief kinds, called red and white corpuscles, from their color. Plasma is a colorless liquid, and looks somewhat like water. Plasma contains both food and waste matter. It is composed of albumin (proteids), sugar, fat, mineral salts, gases, and water.

2. Corpuscles. — The red corpuscles make up nearly one half of the weight of the blood; in shape they are like shallow cups. Red corpuscles average about $\frac{1}{3500}$ of an inch in diameter, and $\frac{1}{12000}$ in thickness; taken singly, they have a sort of faint yellowish color, but in bulk they appear red. The red corpuscles contain some iron, which enables them to carry oxygen. In some animals, red corpuscles are much larger than in man. They have no nucleus. White corpuscles are not so well understood. They have a nucleus, and are a little larger than the red ones, being about $\frac{1}{3000}$ of an inch in diameter. There are in the body from 50 to 500 times as many red cor-

puscles as white corpuscles. White corpuscles can change their shape; they also pass through the walls of capillaries, and move about among the cells. They aid in the healing of wounds, and prevent poisons from entering the blood. They also aid in absorption of fats and peptones, and aid in the coagulation of blood. As the red corpuscle is an aid in nutrition, so the white corpuscle is an important agent of repair. (See plate facing page 111.)

3. Coagulation. — An interesting and useful property of blood is its tendency to coagulate, or clot. In a few minutes after blood is taken from the body it separates into two parts; some of the albumin of the plasma and the corpuscles forms a jellylike, red colored mass called clot. The remaining part of the blood is a liquid called serum, clear or straw colored, and composed of the same elements as plasma, excepting fibrin. Coagulated blood differs in composition from natural blood by a sort of rearrangement of its parts. Ordinary blood is composed of plasma and corpuscles. Plasma merely gives up some of its albumin, which, now called fibrin, unites with the corpuscles to form clot. The remaining part of the plasma is called serum, which, with clot added, is called coagulated blood.

Clotting stops the bleeding of wounds; it is nature's way of dressing a wound. Clotting is sufficient to stop bleeding of all small wounds, and the larger ones also, if the cut surfaces of the wound are held firmly together with stitches or bandages.

4. Process of Circulation. — What would be the route of a red corpuscle in making a complete circuit of the body? Beginning at the lungs, loaded with oxygen, and having a bright red color, it passes through one of the pulmonary veins to the left auricle, then through the

mitral valve into the left ventricle; it passes the semilunar valve into the aorta, then through the aorta and its branches to the capillaries. Upon entering a capillary, the corpuscle gives up its oxygen, loads up with waste material, changes its color to a dark red, and passes on through the capillary into a small vein. It then begins floating through the veins, passing the valves into larger and larger streams, until it reaches the inferior or superior vena cava. Passing through the vena cava, it enters the right auricle; it passes then through the tricuspid valve into the right ventricle, then through the semilunar valve into the pulmonary artery, then to the lungs, where it gives up its load of waste material, and loads up again with oxygen for another trip, and again changes its color to a bright red.

5. Kinds of Circulation. — There are four kinds of circulation, two principal, and two subordinate. The two principal ones are called *pulmonary* and *systemic;* the two subordinate ones are the *portal* and the *capillary*.

The systemic circulation begins with the left ventricle, and includes the movement of the blood in the arteries, the veins, the right auricle, and to the right ventricle. It carries nutriment to the tissues and removes waste.

The pulmonary circulation begins with the right ventricle, and includes the flow of the blood through the pulmonary artery, the lungs, the pulmonary veins, the left auricle, to the left ventricle. It purifies the blood.

The capillary circulation is the movement of the blood through the capillaries, the osmosis, or passage of nutriment through the walls of the capillaries to the cells, and the taking up of waste material from the cells. It is subordinate to the systemic circulation, which it aids, its object being to feed the cells.

The portal veins take up the blood of the stomach, spleen, and intestines, carry it through the portal vein to the liver, where it is modified, taken up by the hepatic veins, and conveyed to the inferior vena cava. The portal circulation is subordinate to the pulmonary in the kind of work done; one of its functions is to purify partially some very bad blood before it goes to the lungs.

6. **Forces of Circulation.** — There are five forces that aid in circulating the blood: (1) contraction of the heart, which is the chief; (2) atmospheric pressure; (3) elasticity of arteries, with the muscular coat contracting behind the pulse wave; (4) muscular pressure on the veins, assisted by their valves; and (5) capillary attraction, aided by the osmosis of their fluids and gases.

7. **Rate of Circulation.** — The faster the heart beats, the sooner the blood can make an entire circuit of the body. At an average pulse beat, from a fiftieth to a sixtieth of the blood of the entire body is moved forward. At this rate, all of the blood of the body could pass through the heart within one minute; but this is seldom ever done. Some portions of the blood move on rapidly, while other portions are detained. A given portion of blood may make the entire circuit of the body in twenty-four seconds, while as a general thing the entire blood of the body makes a complete circuit in two minutes. Poisons or food, after entering the blood, should reach the tissues within two minutes.

8. **How Cells take Nourishment.** — Albumin, mineral food in liquid form, and water reach the cells by osmosis, that is, soak through the walls of the capillaries. Each cell is surrounded by food in liquid form. The food soaks into the cell through the cell wall. The cell takes in water and air, which it gets from the blood. So each

cell actually eats, drinks, and breathes. The cell gives off carbon dioxide, waste water, some minerals, and other waste matter.

9. How Arteries and Veins Differ. — The following are the chief differences between arteries and veins: arteries are very elastic, while veins are not. Arteries have no valves, veins have; arteries branch at sharp angles, veins at large angles; arteries carry blood from the heart, veins toward the heart; arteries begin at the heart, veins at the capillaries; arteries, with one exception, carry pure blood, and veins, with one exception, carry impure blood; in arteries the flow of blood is by jets or spurts, in veins the flow is constant; arteries are deep-seated, veins more superficial; arteries remain open after death, or whenever empty, veins collapse when empty.

OUTLINE SUMMARY

1. *The Blood.* 1. Amount — six to eight quarts.
   2. Color — arterial blood scarlet, venous blood crimson.
   3. Parts — plasma, or the liquid part, and corpuscles.
   4. Corpuscles — two chief kinds, red and white.
   5. Plasma — proteids, sugar, fat, mineral salts, gases, water.
2. *Corpuscles.* 1. Red — circular, very small, color due to hemoglobin.
   2. White — nucleated, larger than the red ones; aid in healing, in repair, resisting poisons, and absorption of food.
3. *Coagulation.* 1. When — soon after it leaves the body, blood coagulates, or clots.
   2. Parts — fibrin and serum. Explain each.
   3. Use — stops bleeding.
4. *Process of Circulation.* 1. Route — trace route of red corpuscle.
   2. Changes — note the changes in function and color of blood.
5. *Kinds of Circulation.* 1. Primary, or principal.
   (*a*) Pulmonary — flow of blood from right ventricle to left auricle, inclusive.
   (*b*) Systemic — flow of blood from left ventricle through the body and back to right auricle, inclusive.
   2. Secondary, or subordinate.
   (*a*) Capillary — movement of blood through capillaries, giving up food and taking up waste matter.

(b) Portal — taking up blood from stomach, intestines, and spleen, and conveying it to the liver; then taking it from liver to general circulation.

6. *Forces of Circulation.* 1. Names — five forces. Make statement. 2. Relative value — heart beat is first.
7. *Rate of Circulation.* 1. Irregularity — a portion of blood may move faster than the rest.
   2. Complete circuit — all blood in two minutes at most.
8. *How Cells take Nourishment.* 1. Osmosis — nutrition, water, and air soak through wall of capillaries, and surround cells.
   2. Entering the cell wall — food soaks through the cell wall.
9. *How Arteries and Veins Differ.* 1. Structure. Make statement. 2. Use. Make statement.

QUESTIONS

1. What are the *parts*, *color*, *amount*, and *corpuscles* of the blood?
2. What is the function of the corpuscles?
3. What is coagulation? Explain fully.
4. What is the route of a red corpuscle in making a complete circuit of the body?
5. What are the kinds of circulation? Describe each.
6. What is the process of circulation? What the rate?

CHAPTER XXIII

HYGIENE OF THE CIRCULATION

1. Flow of the Blood. — The amount of blood needed by a cell depends upon its work. When more food and oxygen are needed, the heart beats faster, and breathing is increased. Violent exercise, or hard physical labor, is followed by a stronger and faster heart beat, the flow of more blood, the enlargement of vessels, and redness of skin. Force and frequency of the heart adapt themselves to the needs of the cells, but if very hard labor is long continued, the heart, like any other muscle, will begin to lose its power; it may wear until it cannot supply blood enough for even moderate work. Violent exertion may cause heart failure, or rupture of a blood vessel.

2. **Fainting.** — When the heart cannot send enough blood to the cells, the brain is the first to feel the effects of it. The brain cells cannot work, consciousness suspends, and the patient sinks into a sort of sleep, called fainting; he can be restored by sending more blood to the head. Three things should be done quickly: (1) place the patient in a horizontal position, or with the head and shoulders even a little lower than the rest of the body; (2) stimulate the heart by injecting a remedy, or by exciting the reflexes, as by dashing cold water in face; and (3) rub limbs toward the heart to force blood that way. The patient will soon revive. Care should be taken not to overstimulate, as a violent rush of blood to the head may do harm.

3. **Temperature and Circulation.** — Extreme heat or cold is injurious. Either, if continued, may permanently affect the parts exposed. At first, heat increases the circulation, but later, exhaustion follows and the circulation decreases. Sudden heat is more likely to produce these effects. Cold increases the circulation, like a tonic, but if long continued, decreases it; this is true of both the body as a whole, and single parts, as the hands, feet, or ears. Frostbite follows the second effect. Heart sedatives or cold may be used to overcome the effect of heat, and stimulants and hot fluids to overcome the effect of cold. Permanently cold hands and feet are due to bad circulation; the condition may be improved by treatment and proper dressing.

4. **Exercise and Circulation.** — The effect of exercise is first felt in the cells, which require more energy and food and give off more waste. The exercise sends the blood to the heart, and the heart sends the blood bounding to the cells in answer to the call for more food and oxygen. Oxidation and animal heat are increased. Exercise is

one of the best means of increasing repair, animal heat, and the removal of waste.

5. **Nervous Shock.**—Circulation, breathing, and other vital processes are under the direct control of the nerves. Anything that affects the nerves will affect the vital processes. Any excitement of the nerves, as anger, grief, love, and hatred, influences circulation; some emotions send the blood to the heart, and make us pale; others make the heart beat faster and send the blood to the surface, causing us to blush. Nerves do this by acting on the muscles in the walls of the arteries. The blushing of a schoolgirl, and the paleness of a schoolboy when about to be punished, are interesting problems in physiology.

6. **A Cold and Circulation.**—Taking a "cold" is primarily the closing of the pores of the skin, and forcing upon the lungs, throat, and nose the waste that usually passes through the skin. A cold also involves the nerves, liver, kidneys, and bowels. It makes venous blood more impure as it must carry so much more waste. A cold affects the circulation by reducing its force and increasing its load. The lungs, throat, and nose become congested. These conditions prepare the body for consumption and other diseases.

7. **Contagions.**—The blood is an important factor in contagions, or "catching" diseases. Most diseases are due to germs that get into the system. Such diseases as smallpox, measles, typhoid fever, scarlet fever, and diphtheria are caught in this way. The blood carries the germs and their poisons to the tissues. In some cases, like typhoid fever, the blood is loaded with the germs of the disease. Many disease germs enter the body through open wounds; we may inhale germs, or get them in

drinking water and food; in all these ways they finally get to the blood, which carries them to all parts of the system, and aids them in their work of destruction and death.

8. Inflammation.—Inflammation is caused by living germs, and is known by redness, swelling, and pain. As soon as a cut or injury is made, the arteries bring large quantities of blood to the wound; this blood causes the redness. White corpuscles gather in great numbers and cause the swelling; the swelling causes pressure on nerves, which produces pain. In every stage of inflammation, white corpuscles gather by the million and fight the germs; a large quantity of the fluid portion of the blood is poured into the wound to help carry on the fight. Pus, the matter formed in the wound, is made up of dead germs, dead corpuscles, dead tissue, and some of the liquid portion of the blood. If germs are kept out of a wound, there will be no pus; wounded tissues will then unite and heal rapidly. Any medicine that will kill germs is called a *disinfectant;* such medicines, when put into a wound, kill germs and enable the wound to heal.

OUTLINE SUMMARY

1. *Flow of Blood.* 1. Regulated — by need of cells for nourishment.
   2. Strain — if force and frequency of heart are much increased and long continued, the heart will begin to lose its power.
2. *Fainting.* 1. Cause — lack of blood in brain.
   2. Remedies — horizontal position; stimulate heart.
3. *Temperature and Circulation.* 1. Extremes of heat and cold — if long continued, injurious.
   2. Immediate effects — both increase circulation at first, then decrease it.
   3. Remedies. Make statement.
4. *Exercise and Circulation.* 1. Effect — cells require more food and energy, and make more waste material.
   2. Movements — two, one in veins, and one in heart and arteries.
   3. Oxidation — more oxidation and more animal heat.

5. *Nervous Shock.* 1. Nervous action — influences the circulation.
   2. Mental states — love, hate, fright, etc., affect circulation.
6. *A Cold and Circulation.* 1. Effects of a cold — the liver, kidneys, bowels, and nerves.
   2. The circulation — decreases the power and increases the load.
   3. Vitality — a cold greatly reduces it.
7. *Contagions.* 1. Germs — the blood aids contagions by carrying disease germs.
   2. Waste — blood chief agent in removing waste of diseases of contagions.
8. *Inflammation.* 1. Symptoms — redness, swelling, and pain; the blood is an important factor in all.
   2. Arresting disease — the blood, with its corpuscles and fluid, is a great factor in fighting disease germs.

QUESTIONS

1. What is the effect of long-continued strain upon the heart?
2. What is the cause of fainting? Remedies?
3. How do temperature and exercise affect circulation?
4. How does shock affect circulation? Effect of a cold?
5. How does the circulation aid contagious diseases and inflammation?

CHAPTER XXIV

HYGIENE OF THE CIRCULATION (*continued*)

1. Bleeding. — It is important to know first where the blood comes from. Blood from veins flows in a steady stream, while from an artery it comes out by spurts, or jets; blood from a vein is dark, or crimson, and from an artery it is light, or scarlet. Bleeding from an artery is the most dangerous. A person may lose as much as one fourth of his blood and live, but he will be very weak; if half of the blood be lost, death will follow. A very slight wound may be very dangerous, and a deep wound almost harmless; it depends upon what is cut, and the amount of blood lost. The exact nature of the wound should be learned, even before steps are taken to stop the

flow, if it can be done without danger. If arteries are injured, work should be rapid and thorough; if only veins are injured, more time can be taken; in either case, time should be taken to cleanse the wound, to remove all foreign bodies, and to disinfect well.

The blood should always be stopped in the simplest and most effective way. If the blood flows from veins, it may be stopped by pressing the walls of the wound together, and holding them until the blood coagulates. If the wound is too great to be closed by pressure, then a bandage must be applied. A good one can be made of an ordinary handkerchief by tying it in a double knot around the wounded limb, turning the knot inward upon the vessel, passing a stick through the loop, and twisting it until it is drawn very tightly. If only veins are injured, the bandage should be on the opposite side of wound from heart. When the blood is stopped, the wound should be dressed by cleansing, disinfecting, and bandaging, stitching when necessary. All materials should be sterilized by heat.

If the blood flows in jets, place the ligature between the wound and the heart, as this blood comes from an artery. If the flesh is torn or crushed, a mass of absorbent cotton should be applied to the wound before the bandage is put on. Small veins should be treated with something to contract them, as powdered alum. Dry earth is sometimes applied to a wound to stop the flow, but this may infect the wound, or irritate it so as to prevent healing. In the case of spitting blood, it must first be determined where it came from. If from the throat, it will appear as any other venous blood; something like a solution of alum will check it. If the blood comes from the lungs, it will be a bright red and frothy; it may be checked by taking some lemon juice or vinegar. If the blood comes from

the stomach, it will be dark in color, and probably mixed with food ; it may be checked with lemon juice. If these simple remedies do not stop the flow of blood, call a physician. For bleeding at the nose, apply cold water, or a solution of alum. Pressing the nostrils together with finger and thumb is usually sufficient. Cold water is useful in nearly all forms of bleeding.

2. Repair and Healing. — Repair is made by first excluding bacteria, and collecting at the wound all the necessary materials, as extra blood, food, and white corpuscles. The old dead cells caused by the wound are absorbed and carried off with lymph. New flesh is made by putting new cells in place of the old ones. The white cells assist in removing the old material and in destroying bacteria. While this is going on, new skin cells are being placed around the edges of the wound; finally, new skin spreads over the wound. Sometimes the new flesh grows faster than the new skin ; at other times, exactly the reverse is true. In case of the former, the flesh is pushed up above the surface of the skin, becomes soft, very red, and refuses to heal ; it is called *proud flesh ;* this has to be cut off or burned off, as it is not healthy tissue ; then the skin can heal over it. If the skin grows faster than the flesh, it usually covers up some waste material ; the sore has to be reopened, the waste removed ; then the healing of flesh and skin will go on together. Healing goes on rapidly if germs are kept away, and waste removed as needed.

3. Treating a Wound. — There are several necessary steps in treating a wound: (1) stopping the flow of blood, (2) cleansing, (3) sterilizing, (4) draining, and (5) stitching and bandaging. It is very important that the wound be properly cleansed ; all instruments should be sterilized, and water used should first be boiled; the oper-

ator's hands should be thoroughly cleaned, and then bathed in alcohol, or a weak solution of carbolic acid. These articles should be kept in every home and in the medicine case of every schoolhouse. The wound should be sterilized with carbolic acid, about one part of pure carbolic acid to fifty parts of water. No sticky salve should be put on a sore. If the wound is large, it should be filled with gauze, which will take up the waste material. A few stitches may be necessary to hold the walls of the wound firmly together at every point; then a good bandage is put on to keep out bacteria, to hold the parts in place, and to prevent any new injury to the wound. If possible, it is best to bind up a wound in its own blood, if the blood is healthy.

4. Alcohol and Circulation. — Alcohol affects the circulation and all functions that depend upon it: (1) it deprives the blood of much of the food it should carry; (2) it injures health by bloating; (3) it deprives the body of much of its oxygen; (4) it makes a surplus of heat; (5) it destroys muscular power in the arteries; (6) it weakens the heart by overwork; (7) injures the brain; and (8) causes loss of power to endure extremes of heat and cold.

It must not be forgotten that while alcohol excites the cells to greater activity, it does not give them additional strength for their work, and finally results in a state of cell depression. It hinders digestion and disturbs the liver; in doing this, it weakens the blood by decreasing its nutritive element. In case of beer drinkers, too much water reaches the cells, and makes the muscles large, infirm, and weak.

Alcohol takes up much oxygen from the body; this produces two bad results, namely, poisoning the blood, and

leaving much unoxidized food. The effect of this is to deprive the tissues of much nutriment, and to aid the formation of *uric acid* from the unoxidized particles of food. Uric acid is a dangerous factor in rheumatism, indigestion, and many nerve diseases.

Alcohol in the system must be oxidized; this produces much extra heat and increases circulation. The blood rushes into the capillaries, making the drunkard's "blush." This extra blood reduces the power of resistance, and retards the healing of wounds. In all such diseases as typhoid fever, pneumonia, and consumption, the death rate among drinkers is much higher than among those who do not drink.

Alcohol weakens the heart by overwork, a lack of nutrition, and a surplus of water. Alcohol also affects the nerves of the heart. In these various ways the well-known "whisky heart" is produced, which usually results in death.

Alcohol prevents the blood from properly nourishing the brain. Most people think that a drink of alcohol "braces" one up by giving added strength, but this is not true; alcohol really weakens the brain until it is not so sensitive to fatigue. The weakness of the brain results in loss of mental power, moral power, and will power. Owing to general loss of strength and resistance, the drinker cannot endure extremes of either heat or cold. Alcohol does heat the body temporarily, but a period of chill and depression follows. It is also true that drinking alcohol in hot weather cools the body by increasing sweat, but this is unnatural, and weakens the glands of the skin.

5. Tobacco and Circulation. — Tobacco is very injurious to the tissues of the whole body. Tobacco first attacks the nerves, then all vital processes. It weakens the

muscles; it affects the heart, and makes its action very irregular; the heart is first too slow, then too fast. Palpitation is very common, and there is danger of heart failure, because the walls of the heart are not properly nourished. Short breath ensues, because the blood does not properly circulate in the lung. One loses his power to work, grows prematurely old, and finds an early grave.

When the heart is weakened and the whole system poisoned with nicotine, a little additional strain from disease is dangerous; the heart may fail. Many a death occurs in this way.

OUTLINE SUMMARY

1. *Bleeding.* 1. Source — find source. How?
   2. Nature of wound — try to find nature of wound.
   3. Dressing — clean up well, stop blood, and dress wound.
   4. Ligature — in veins, place ligature on opposite side from heart; in arteries, place ligature between the wound and the heart.
   5. Spitting blood — first ascertain source, then apply remedies.
2. *Healing.* 1. Agencies — extra blood, nutrition, and white corpuscles.
   2. Bacteria — all germs must be excluded.
   3. How effected — by depositing new cells in place of old ones.
   4. Proud flesh — healing of flesh and skin must go on together.
3. *Treating a Wound.* 1. Steps — name five steps.
   2. Antiseptics — the strictest cleanliness and antiseptic treatment.
4. *Alcohol and Circulation.* 1. Effects — name eight effects.
   2. Cell depression — alcohol creates no new strength; its final result is cell depression.
   3. Resistance — great loss; diseases easily attack a drunkard.
5. *Tobacco and Circulation.* 1. Effects on blood — poisons it.
   2. Heart — weakens it, and interferes with circulation.

QUESTIONS

1. What means should be employed to stop bleeding?
2. What causes healing to take place?
3. What are the steps in dressing a wound?
4. What is the effect of alcohol on the circulation?
5. How does tobacco affect the circulation?

CHAPTER XXV

THE LYMPHATIC SYSTEM

1. General Description. — The plasma of the blood passes through the walls of the capillaries usually in greater quantities than needed, and fills the lymph spaces between the cells. With the lymph spaces the lymphatic system begins. The lymphatics, or absorptive system, as they are sometimes called, are a system of tubes and glands which assists in the general work of circulation. They carry a fluid called lymph, and serve as drain pipes for the surplus nutriment sent to the cells, and some waste materials. They consist of lymphatic *vessels*, *ducts*, *glands*, and *lacteals*. They extend from the tissues toward the heart, emptying into veins near the heart.

FIG. 36. — Lymphatics of the head and neck, showing the glands, and, *B*, the thoracic duct as it empties into the left subclavian vein.

The waste material carried by the lymphatics does not pass through the walls of the capillaries to the veins; it consists of some dead white corpuscles, water, minerals, and surplus plasma.

2. Lymphatic Vessels. — The small tubes known as lymph vessels are delicate, transparent tubes, well supplied with valves opening toward the heart. The valves give the tubes a knotted appearance. Although much more numerous than veins, they are not found in the brain or spinal cord, nor in the hair, nails, tendons, cartilage, and eyeballs. They are divided into the superficial, and deep-seated, the former lying near the skin, pleura, peritoneum, and other lining, and the latter running with the deep-seated blood vessels. The smallest lymph vessels are smaller than capillaries; they unite into about twenty main tubes for each limb.

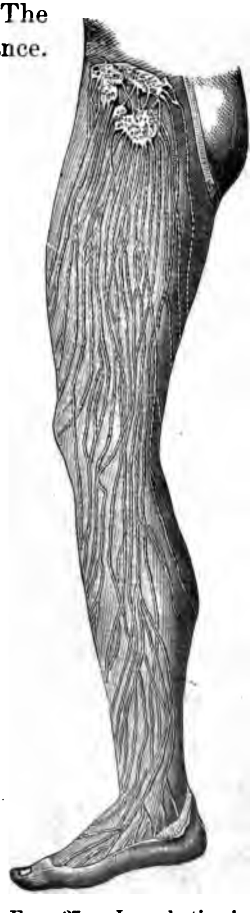
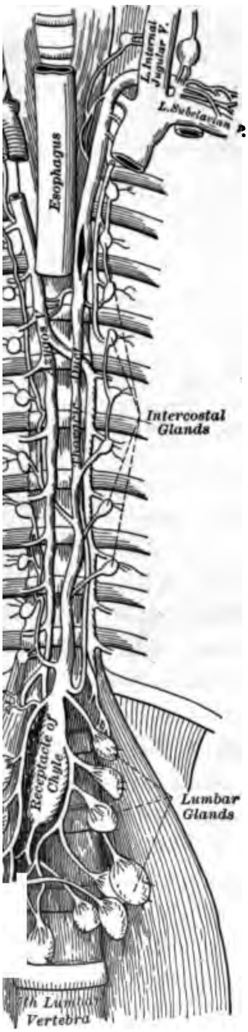


FIG. 37. — Lymphatics in the leg, with glands at the hip.

3. Ducts. — The lymphatic vessels of the right shoulder, arm, lung, upper liver, and right side of the head, unite to form the right lymphatic duct, which empties into the right subclavian vein. The lymphatic vessels of all the rest of the body unite to form the thoracic duct, a tube about as large as a goose quill, and eighteen to twenty inches long, which empties into the left subclavian vein. At its lower extremity it has an enlargement, where the chyle from the intestines is received. It lies along and in front of the spinal column.

4. Glands. — Along the course of the lymphatic vessels there are several small bodies, from a quarter of an inch

n length, called lymph glands, or lymph nodes. The lymphatic vessels enter the glands, divide, subdivide, and reunite within the gland. The use of lymph glands seems to be to filter out injurious substances, and to arrest and destroy poisons. These glands are located in various parts of the body, the more important ones being in the neck and groins.



e thoracic duct and right
mphatic duct.

5. Lacteals.—The villi of the small intestines contain vessels, each villus having a vein, an artery, and a lacteal. The artery supplies its blood, the vein takes up blood to be carried to the liver, and the lacteal takes from the digested food some sugar and some albuminoids, but its chief function is to absorb emulsified fat. These lacteals are lymphatics, and differ from other lymphatics only in the fluids they carry.

Chyle has a white, milklike appearance, from which lacteals take their name. Lacteals, like other lymphatics, empty into the thoracic duct.

6. **Lymph.** — Lymph bathes nearly every tissue of the body; it is found in all the lymph spaces. It is a clear liquid, sometimes slightly straw-colored, except that of the lacteals, which is white. Lymph is slightly alkaline, has a salty taste, but no odor; it is composed of the plasma of the blood, some white blood cells, some waste matter from the cells, and fat globules after meals. It is really blood without the red corpuscles, and with several waste substances taken from the cells.

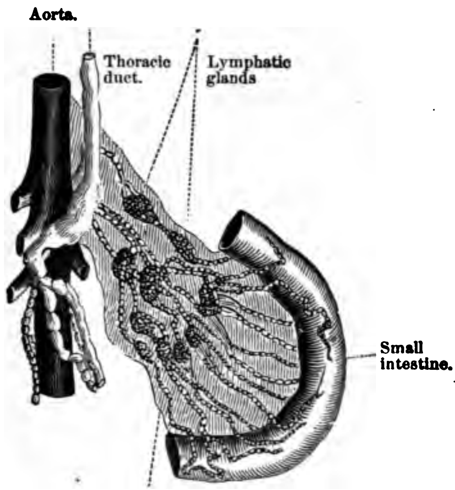


FIG. 39. — Lymphatics of the intestine.

The forces that make lymph flow are (1) pressure caused by its continual formation, (2) contraction of muscles, (3) changes of pressure in the chest from breathing, (4) peristaltic movement of intestines, and (5) pump-like action of villi.

7. **Serum.** — The circulation involves five fluids: (1) blood, (2) plasma, (3) serum, (4) lymph, and (5) chyle. Blood consists of plasma and corpuscles. Serum is plasma after it has lost its fibrin by coagulation, and is composed

of the mineral salts, water, and a portion of the albumin of the blood. Serum is a clear fluid resembling water, sometimes of a light straw color; this fluid bathes all serous membranes; it is the fluid within a blister, and the fluid of dropsy; it is not water, as commonly supposed, nor is it plasma.

8. **Work done by Lymphatics.** — The function of the lymphatic system is simple, but very important. The material for the building and repair of all tissues is the plasma of the blood; it soaks through the walls of the capillaries, and bathes every cell in the body, the cell taking up whatever is needed. But the cells cannot use up all the plasma, generally, and the remainder must be moved, renewed with nutriment, and brought back again. At the same time the cells are giving off much waste, most of which passes through the walls of the capillaries into the blood, but some remains in the plasma around the cells. While this is going on, many white corpuscles pass through the capillary walls and float about the cells. These three substances, the surplus plasma, surplus waste material, and surplus white corpuscles, compose the material known as lymph. The true function, then, of the lymphatics, is to gather up the surplus of the blood vessels and waste material, and give it over to the blood again. The additional function is that of those lymphatics known as lacteals, which carry chyle from the intestines to the thoracic duct.

9. **Accessory Glands.** — As a part of the lymphatic system, there are two glands, known as the *thymus* gland and the *thyroid* gland. The thymus gland is located just above the heart. Its function is not well known, but it seems of little importance. The thyroid gland is in the front of the neck, near the surface. It performs an important

function, which is to overcome poisons, and to make a secretion which affects assimilation, especially that of the central nervous system. It is the seat of the disease known as goiter.

10. Diseases. — The chief diseases of the lymphatics are dropsy, scrofula, and goiter.

When the amount of lymph is greater than can be carried off by the lymphatic vessels, it produces a uniform swelling, known as dropsy. This is temporarily relieved by tapping, or drawing off the serum. When the lymphatic vessels carry poisons, the glands swell up and are painful. Certain poisons cause them to inflame and sometimes break down in a disease known as scrofula. In the case of erysipelas, boils, and many other inflammations, the lymph glands swell, break down, and form running sores, or abscesses. The lymph glands are involved in nearly all cases of poisoning. In goiter, the thyroid gland enlarges. It is a nervous disorder, and the enlargement of the gland is a symptom, just as dropsy is a symptom of the real disease. The gland may become so large as to interfere with breathing. It is more common in females than in males. It is usually curable.

OUTLINE SUMMARY

1. *General Description.* 1. Lymph spaces — spaces around the cells.
   2. Organs — lymphatic vessels, ducts, glands, and lacteals.
   3. Work — to carry away surplus food and waste material.
   4. Course — from tissues toward the heart.
2. *Lymphatic Vessels.* 1. Description — small tubes, transparent and valvular.
   2. Where found — in all tissues except brain, spinal cord, hair, nails, tendons, cartilage, and eyeballs.
3. *Ducts.* 1. Right lymphatics — made up of the vessels from the right shoulder, arm, lung, upper liver, and right side of head; empties in right subclavian vein.
   2. Thoracic duct — receives lymph from all the rest of the body, and empties into the left subclavian vein.

4. *Glands*. 1. Location — along the course of the lymphatic vessels, in the neck and groins.
   2. Use — to filter out injurious substances and destroy poisons.
5. *Lacteals*. 1. Location — in villi of small intestines.
   2. Use — to absorb foods, especially emulsified fats.
6. *Lymph*. 1. Description — a liquid, usually clear, but sometimes slightly straw-colored; white in lacteals.
   2. Composition — white blood cells, fat, plasma, waste materials.
7. *Other Fluids*. 1. Names — besides lymph, blood, plasma, serum, and chyle.
   2. Definitions. Make definition of each.
8. *Work of Lymphatics*. 1. Aid to veins — gathers up surplus plasma, waste materials, white corpuscles, and bacteria around the cells.
   2. Aid to digestion — carries chyle to the general circulation.
9. *Accessory Glands*. 1. Names — thymus and thyroid.
   2. Functions — thymus seems of little importance; the thyroid secretes a fluid which affects assimilation, particularly in the central nerves, and overcomes poisons. Seat of goiter.
10. *Diseases*. 1. Names — dropsy, scrofula, and goiter.
    2. Cause — usually more waste or poisons than the lymphatics can carry away, in the first two; goiter is a nerve disease.

QUESTIONS

1. What are *lymph spaces*?
2. Describe the lymphatic vessels.
3. Into what do the lymphatic ducts empty?
4. State the location and the function of lymphatic glands.
5. What is the composition of lymph?
6. What is the function of the lymphatic system?
7. What are the leading diseases of the lymphatics?

CHAPTER XXVI

THE RESPIRATORY SYSTEM

1. Organs. — The organs of respiration are (1) the nose, (2) pharynx, (3) larynx, (4) trachea, (5) bronchi, (6) lungs, and (7) diaphragm. The nose and pharynx are parts of other systems, also, and are described elsewhere.

2. The Larynx. — The larynx is the chief organ of voice; it is commonly known as Adam's apple. It is a short tube connecting the pharynx above and the windpipe below. The larynx is composed of cartilages, the vocal cords with their muscular connections, and a lining membrane. The framework is composed of nine separate cartilages, the most important of which are the *thyroid* and the *epiglottis*. The thyroid is the largest, and constitutes the chief part of the larynx; it is circular, largest in the upper portion, and is somewhat flattened behind. The prominent point in Adam's apple is a projection of the thyroid cartilage.

The epiglottis is a leaf-shaped cartilage, located behind and at the base of the tongue, attached at one end to the thyroid cartilage, and operated something like a trap door. The opening between the pharynx and larynx is called the glottis. The glottis is open when we breathe, but closed when we swallow. If one swallows and breathes at the same time, some food will be drawn into the windpipe and lungs. This will cause one to strangle and cough until the food particles are forced back into the pharynx.

The vocal cords are two thin, elastic bands or membranes, stretched across the upper end of the larynx. They can be tightened, relaxed, or brought close together at will; any change of the cords makes a change in the voice.

3. Trachea. — The trachea, better known as the windpipe, is a tube about five inches long, and nearly an inch in diameter, and extends from the larynx to the bronchi. The trachea is composed of rings of cartilage, from sixteen to twenty in number, set edge to edge; they are connected by a fibrous membrane containing some muscular

fibers. The construction of the tube is such as to make it both flexible and rigid ; it always stands open.

4. **Bronchi.** — The windpipe divides into two branches, called bronchi; each bronchus is composed of rings somewhat like those of the windpipe, and lined with a mem-

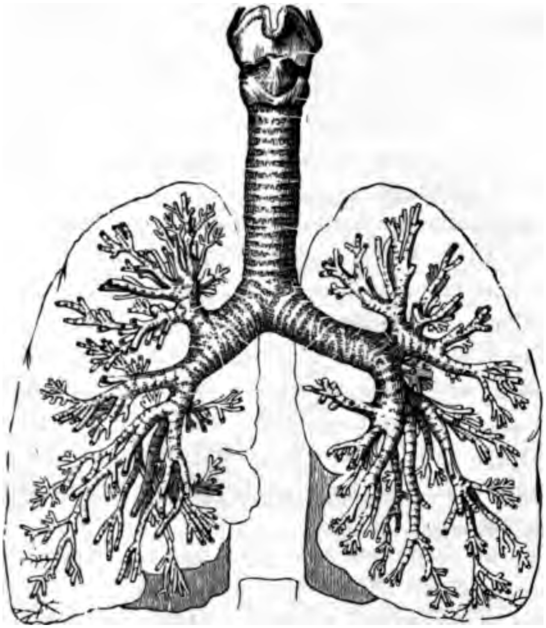


FIG. 40. — Larynx, trachea, bronchi, and bronchial tubes.

The air vesicles are all removed. If present, they would fill all the spaces and cover the air tubes from sight.

brane. The bronchi divide and subdivide until the branches reach every portion of the lung, and open into very small oblong bodies, or bags, called air cells.

5. **Lungs.** — The lungs are two large vascular bodies occupying almost all the space of the thoracic cavity. They are known as the right and left lung. There is a

small open space between them occupied by the heart, some of the large blood vessels, nerves, trachea, and thoracic duct. The lungs are of conical form, with the apex upward. The apex reaches a point slightly above the level of the first rib, and the base of the lungs touches the upper surface of the diaphragm. The external surface of the lungs is convex, fitting into the cavity of the thorax.

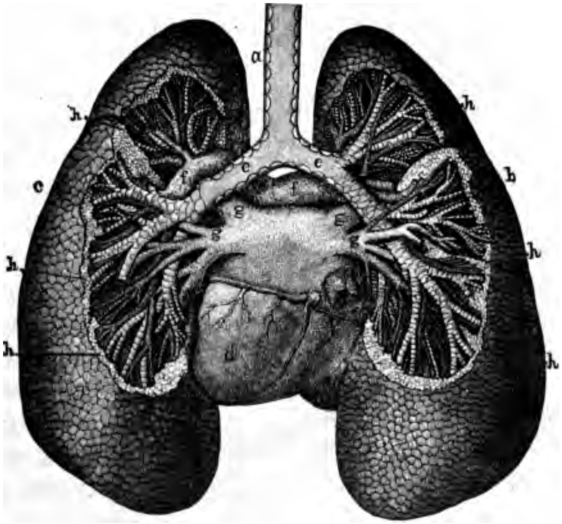


Fig. 41.—Interweaving of the air tubes and blood vessels in the lungs.

a, windpipe; *b*, *c*, right and left lung; *d*, heart; *e*, *e*, divisions of the great air tubes going to the right lung and the left lung; *f*, *f*, arteries carrying the blood from the heart to the lungs; *g*, *g*, veins carrying the blood from the lungs to the heart; *h*, *h*, *h*, *h*, air cells at the terminations of the air tubes.

The internal and under surface of the lungs is somewhat concave. The right lung is the larger and broader, on account of the position occupied by the heart; it is, however, about an inch shorter than the left lung, because of the position of the liver.

The right lung is divided by fissures into three lobes.

The left lung, being somewhat narrower than the right lung, has only two lobes. The lungs are connected to the trachea and the heart by what are known as lung roots, very strong attachments.

The lungs have two coverings: the external, or serous coat, and the internal, or areolar coat. At birth the color of the lungs is a very delicate pink, which grows darker with age. The lungs are very elastic. As we breathe, they expand and contract. They are very light in weight, and will float in water because of the air they contain. The weight of the lungs is about forty-two ounces, the left lung being about two ounces lighter than the right lung.

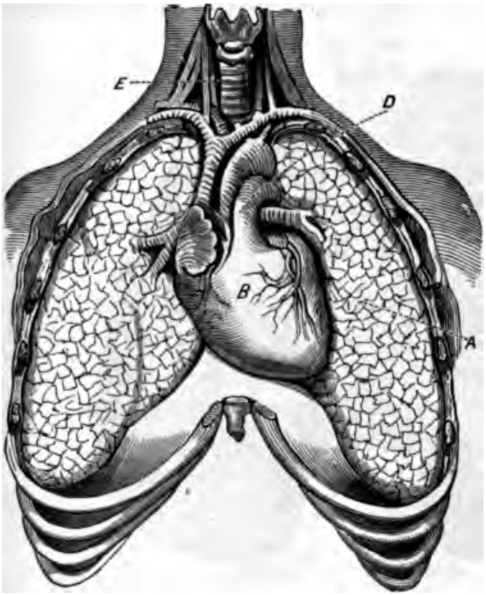


FIG. 42.—The cavity of the chest, showing the positions of the heart and the lungs.

A, left lung; *B*, heart; *D*, pulmonary artery; *E*, trachea, or windpipe. (Tracy.)

In structure the lungs are porous, elastic, and spongy. The body of a lung is made up of smaller bodies called lobules, bound together by connective tissues, and composed of the end of the bronchus and its air cells, the capillaries, lymphatics, and nerves. Each lobule has a fine network of capillaries. The bronchi of the lungs are

merely subdivisions of the trachea, which continue to subdivide until the little lobes or air cells are reached.

The air cells and fine capillaries exchange their oxygen and carbon dioxide in the lungs. They run so close together that there is only a single wall between them.

The lungs can hold something over 300 cubic inches of air. A portion of this air, which always remains in the lungs, and cannot be forced out, is called *residual air*. There is always a large quantity of air that the lungs may force out, which is called *reserve air*, and amounts to about 100 cubic inches more than is exhaled in normal breathing. By forced inspiration, the lungs can take in about 100 cubic inches above normal; this is called *complemental air*. The amount that is actually moved in and out in breathing is called *tidal air*. The following figures will aid the memory: —

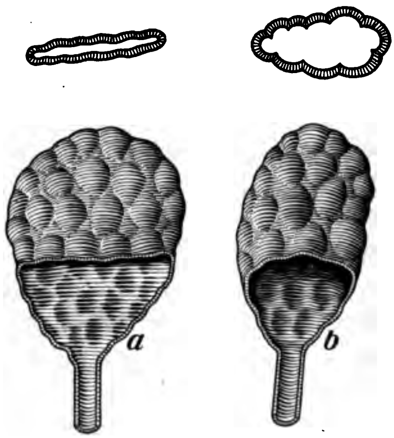


FIG. 43. — Air sacs at the end of air tubes in the lungs.

a, from a lung not exercised; *b*, from a lung well exercised. The figures above are cross sections magnified.

Capillaries and lungs (about)	330 cubic inches.
Tidal air (about)	30 cubic inches.
Complemental air (about)	100 cubic inches.
Reserve air (about)	100 cubic inches.
Residual air (about)	100 cubic inches.

6. Linings. — The entire respiratory system is lined with mucous membrane; the outer surface of the lungs and the thoracic cavity are lined with serous membrane.

The lining of a portion of the nose, trachea, and the bronchial tubes has a layer of cells that have fine, hair-like projections called cilia, which possess the power of motion, and arrest dust and other foreign material taken in with the breath.

The serous membrane, which covers the cavity of the chest and lungs, is continuous, and is called the *pleura*. It is a closed sac, and, like all serous membranes, it secretes a fluid which moistens the parts, preventing friction and chafing; otherwise the movement of the lungs would keep the pleura inflamed.

7. Diaphragm. — The diaphragm is not strictly a respiratory organ, but it aids in respiration. It is the septum between the thoracic and abdominal cavities, the former containing the lungs, heart, and many vessels and tubes, and the latter containing the stomach, liver, intestines, kidneys, and other organs. It is both muscular and fibrous, and has the power of contraction and relaxation at will. When it contracts, it reduces the size of the thorax, and when it relaxes, it increases the thorax; and in this way it aids in breathing, laughing, crying, coughing, and other respiratory acts.

OUTLINE SUMMARY

1. *Organs.* 1. Names. Make statement.
   2. Use — respiration, some used in common with other systems.
2. *The Larynx.* 1. Common name — Adam's apple.
   2. Parts — cartilages, vocal cords, muscular connections, and lining membrane.
   3. The epiglottis — opens when we breathe, and closes when we swallow.
   4. Vocal cords — thin, elastic bands, stretched across the larynx.
3. *Trachea.* 1. Size — about five inches long and nearly an inch in diameter.
   2. Rings — sixteen to twenty incomplete rings set edge to edge.
   3. Branches — two branches called bronchi.

4. *The Bronchi.* 1. Parts — incomplete rings and membrane like trachea.
   2. Divisions — divide and subdivide until they reach every part of lungs, and terminate in air sacs.
5. *Lungs.* 1. Location — two large vascular bodies occupying the thorax.
   2. Shape — conical, with apex upward.
   3. Surface — convex above, concave below, and covered with serous membrane.
   4. Comparative size — right a little broader and thicker, but shorter.
   5. Lobes — right lung has three, and left two.
   6. Lung roots — connections with trachea and heart.
   7. Color — at birth a delicate pink, but grows darker with age.
   8. Structure — porous, elastic, and spongy.
   9. Osmosis — exchange their oxygen and waste materials.
   10. Capacity — over three hundred cubic inches of air.
6. *Linings.* 1. Respiratory system — continuous lining of mucous membrane.
   2. Cilia — the cells having fine, hairlike projections.
   3. Thoracic lining — serous membrane, the pleura.
7. *Diaphragm.* 1. Definition — septum between thoracic and abdominal cavity.
   2. Composition — both muscular and fibrous.
   3. Work — aids in many respiratory acts.

QUESTIONS

1. What are the organs of respiration?
2. Describe the *larynx*, *trachea*, and *bronchi*.
3. Give the *location*, *size*, *shape*, and *structure* of the lungs.
4. What are air sacs?
5. Describe the covering and lining of the lungs.
6. What is the diaphragm? What has it to do with the circulation?

CHAPTER XXVII

BREATHING

1. Oxygen. — The amount of oxygen required for the system is about twenty-four ounces in twenty-four hours. Ordinary air is nearly 80 per cent nitrogen, 20 per cent oxygen, and a small amount of some foreign or mixed gases, as carbon dioxide. Nitrogen merely weakens the

oxygen, and the foreign gases are usually injurious. But the air which comes from the lungs is very different; it has about 16 per cent of oxygen, and about 4 to 5 per cent of carbon dioxide. In breathing, the air gives up about 4 per cent of its oxygen, and takes on about the same amount of carbon dioxide. Exhaled air usually has a very small amount of some organic gases, and some vapor, but the reaction in the lungs is the exchange of some oxygen for almost an equal amount of carbon dioxide.

2. Why we Breathe. — The act of breathing is mostly involuntary, but may be greatly modified by effort. Because of a peculiar feeling, a desire for breath, the air is forced into the lungs by an act called *inspiration*, or inhalation. In a few seconds another uncomfortable feeling appears, and the air is forced out of the lungs by an act called *expiration*, or exhalation. While the desire to inhale and exhale is felt in the lungs, the call comes from every cell in the body. Oxygen is the chief agent in oxidation, from which every cell gets its energy. In order to maintain life, one must breathe about eighteen times per minute.

The amount of expansion of chest is about one inch; by a very deep breath the chest can be expanded two or three inches, and in some cases four inches.

3. Process. — The process of breathing consists of the two simple steps of *inhaling* and *exhaling*. The force that produces the former is the pressure of the air, and the latter, the elasticity of the tissues. When the diaphragm is depressed and the ribs raised, the thoracic cavity enlarges, and the air rushes into the lungs until they are filled. The tissues react in a short time, and expel the inhaled air from the lungs with great force. During the time the air is in the lungs a chemical reaction takes

place, by which the blood is cleansed of its impurities and recharged with oxygen.

Sugar and fat do not become a part of the living cell in health, but albumin does. Oxygen, when it reaches the cells, burns sugar and fat, producing heat and energy. This is the final act of breathing ; its products are carbon dioxide, some organic gases, water, and some minerals. Oxygen burns at least a part of the cell's albumin. Oxidation, being a vital process, requires the aid of living tissues. Some of the fat of the body is taken up by the cells of the lungs, and oxidized. Sugar is absorbed by the liver, and some of it oxidized there. Oxidation scarcely occurs in the fluids of the body when they are in a state of motion ; it takes place after they reach the tissues.

4. Exchange of Gases. — In ordinary fire, the union of carbon and oxygen requires at least 200 degrees of heat, but they unite or burn within the body at a temperature of less than 100 degrees. Oxidation within the body is a process of making not only heat, but energy, and new tissues. It not only consumes dead materials, but it changes fresh materials into living cells. The carbon dioxide is not only a result of simple burning, but of the breaking up of old tissues. The exchange of materials shows the following facts: (1) oxidation really takes place in the cells ; (2) oxidation is the chief end of breathing ; (3) in oxidation, oxygen, sugar, fat, and some albumin are consumed ; (4) heat, energy, new tissue, carbon dioxide, water, and urea are produced ; (5) water and urea are turned back into the blood and thrown off by the kidneys and skin ; and (6) in the lungs pure air gives up oxygen and takes on almost an equal amount of carbon dioxide ; the table below represents more accurately the last statement : —

	Oxygen	Nitrogen	Carbon Dioxide
Ordinary air about . . .	20.6 parts	79.36 parts	.04 part
Exhaled air about . . .	16.04 parts	79.56 parts	4.40 parts

Nitrogen merely dilutes the oxygen, and comes out of the lungs almost unchanged, having no effect upon the body.

5. Effects of Breathing on Air and Blood. — The air contains, when it leaves the lungs, not only about 4 per cent of carbon dioxide that it did not have before entering the lungs, but it has some ammonia and some organic matters which are very poisonous. Oxygen changes the dark red of venous blood to a bright red, the change taking place in the red corpuscles.

There is but little change in the blood as it flows through the arteries and veins. Nearly all changes take place at two points, lungs and capillaries. The changes in the capillaries about balance the change in the lungs. On a very small scale, some changes similar to those in the lungs are going on in other parts of the body, wherever blood comes in contact with the air.

6. Breathing Sounds. — Almost any movement of the breath makes a sound which can be heard through the chest. Coughing, talking, and the obstructed breathing of disease can be heard through the chest walls. The breath, when natural and healthy, makes a sort of blowing sound.

7. Rate of Breathing. — Rate of breathing is modified by age, disease, work, food, exercise, temperature, medicine, the mental states, and vitality. Breathing is more rapid in the young, and in women than men; it is increased by

a stimulant, cold, exercise, food, and by some diseases; it is decreased by sedative medicines, moderate heat, lack of exercise, hunger, and by some diseases. Inspiration is a little shorter than expiration, and should occur once in every four beats of the heart, or about eighteen times per minute. It may vary as much as ten per minute; it should not exceed twenty-four, nor fall below fifteen.

8. **The Voice.** — The voice has two forms, known as speaking voice and singing voice. Voice is produced by the vocal cords. It is modified by the throat, lungs, teeth, lips, and cheeks, the mouth and nose acting as a sort of sounding box. The elementary sounds in all languages are alike, the usual differences being caused by the differences in organs of speech.

9. **Respiratory Center.** — The movements of the diaphragm, ribs, costal cartilages, and other parts of the chest taking part in breathing, are directed by a nerve center called the respiratory center. It is situated in the brain, and all respiration depends upon its work. If this center is injured, breathing is injured. Respiration is stimulated by rousing the center to action; when the action is sudden, we speak of it as "catching the breath." This stimulant may be physical or mental. There are many ways to stimulate this center. Irritating substances along the trachea will produce coughing and sneezing; cold water dashed in the face, a sudden, sharp pain, exercise, and a sudden emotion may act as a respiratory stimulant.

10. **Modified Breathing.** — The following are the usual forms of modified breathing: —

Coughing is due to some irritation, psychic force, or habit. It is begun by deep, continued inspiration and closing of the glottis; it is finished by a sudden, forced current of air through the glottis to the mouth in the form of a

short, violent expiration. It is caused by some foreign substances in the air passages, as dust, a bit of food that has gone the wrong way, or mucus. It may be a reflex act, the point of irritation being in some other part of the body.

Sneezing is that form of coughing in which the air is expelled through the nose instead of the mouth. It may be produced by an irritation in the nose, or any cause that produces coughing, or by excessive light thrown upon the eye.

Hiccough is a quick, short inspiration caused by a sudden contraction of the diaphragm ; the glottis is suddenly closed, and the air breaks against it, causing the well-known sound. This spasmodic action of the diaphragm is caused usually by some form of indigestion, and is sometimes difficult to control. It has been known to cause death. It can be controlled by the will, usually, but frequently requires medical skill.

Hawking is caused by some obstruction in the pharynx or larynx, and is a voluntary expiration to remove the obstructing object.

Spitting is an expiration in which the lips are blown open to emit some useless or disagreeable substance.

Choking is a sudden and complete obstruction of the larynx, or trachea. It is caused by attempting to swallow something too large to pass the opening. It is usually removed by lying down on the face, or inclining the head while some one pounds the back ; this will dislodge the obstruction.

Suffocation is loss of breath, and is caused by preventing the passage of the air, partially or wholly, through the respiratory tract.

Yawning, or *gaping*, is a long, deep, inaudible inspiration through the mouth, widely opened. Yawning is usually

due to a deficiency of oxygen in the body; it may follow exposure to cold, loss of sleep, or overeating.

Sighing is a long, deep, inaudible inspiration followed by a somewhat shorter and audible expiration through the mouth. This is usually due to some psychic state, as anxiety, grief, or suspense.

Laughing is a succession of short expirations, forcible, audible, and sometimes violent, due to some amusing incident.

Crying is very similar to laughing, so much so that it is sometimes difficult to distinguish them; it has, however, a very different facial expression from laughing. Crying is usually caused by emotions of sorrow, but it may be caused by extreme joy.

Sobbing is a succession of short inspirations, more or less convulsive, and accompanied by the closing of the glottis; the sounds are caused by forcing air through the nasal passages or against the closed glottis, as in hiccoughs; sobbing is due to the convulsive action of the diaphragm, and caused by grief.

Snoring is a sound caused by vibration of the uvula. It occurs only when breathing through both the nose and the mouth. It is an injurious habit.

Sucking is a modified form of inspiration; the floor of the mouth is depressed so far as to lessen the pressure. The pressure of the air is sufficient to force into the mouth the substance desired.

Grunting is a short expiration; the sound is made by throwing the vocal cords into vibration. It is usually due to some sudden change of feeling or thought.

Groaning is a rather short voluntary or involuntary expiration whose sound is produced by the vibration of the vocal cords. It is usually due to some form of mental or bodily suffering.

Blowing is a voluntary expiration in which the breath is forced steadily through a small opening, either through the lips, or some tube within the lips.

OUTLINE SUMMARY

1. *Oxygen*. 1. Amount—about twenty-four ounces per day and night.
   2. Common air—about 80 per cent nitrogen, and 20 per cent oxygen and foreign gases.
   3. Exhaled air—contains about 80 per cent nitrogen, 16 per cent oxygen, and 4 per cent carbon dioxide.
2. *Why Breathe*. 1. Oxidation—to supply the cells with energy.
   2. Vital capacity—about 330 cubic inches.
3. *Process*. 1. Steps—inhalation and exhalation.
   2. Force—atmospheric pressure and muscular contraction.
   3. Oxidation in lungs—a large portion of fat.
   4. Oxidation in liver—a large portion of sugar.
   5. Oxidation in cells—sugar, fat, and some albumin.
4. *Exchange of Gases*. 1. Elements burned—oxygen, sugar, fat, and some albumin.
   2. Products—heat, energy, and new tissues; carbon dioxide, water, and urea.
   3. In lungs—pure air gives up oxygen and takes carbon dioxide.
   4. In vessels—in veins and arteries only a slight change, if any.
5. *Effects of Breathing on Air and Blood*. 1. On air.—Make statement.
   2. On blood—Make statement.
6. *Breathing Sounds*. 1. Healthy sounds—natural breathing is a sort of blowing sound.
   2. Rales—when breath is obstructed by mucus or inflammation.
7. *Rate of Breathing*. 1. Varies—depends upon age, disease, work, food, exercise, temperature, the mental state, and bodily acts.
   2. Normal rate—about eighteen times a minute by average adult.
   3. Limits—should not exceed twenty-five, nor fall below fifteen.
8. *The Voice*. 1. Definition—modification of breath when sounds become audible and articulate.
   2. Forms—two, speaking voice and singing voice.
   3. Changes—to suit every emotion; produced by vocal cords, and modified by throat, lungs, teeth, lips, and cheeks.
9. *Respiratory Center*. 1. Location—in the brain.
   2. Stimulation—results in a respiratory act.
10. *Modified Breathing*. 1. Definition—change in rate, form, or intensity of breathing.
    2. Forms—Make statement.

QUESTIONS

1. What part of pure air is oxygen? Describe oxygen.
2. Why do people have to breathe? The process of breathing?
3. What exchange of gases goes on in breathing?
4. What are the *sounds* and *rate* of breathing?
5. What is meant by the respiratory center?
6. What are the chief forms of modified breathing?

CHAPTER XXVIII

HYGIENE OF BREATHING

1. **Abnormal Breathing.** — The capacity of the thorax is increased by depressing the diaphragm, raising the ribs, and expanding chest muscles. In normal breathing the elastic tissue connected with the thorax should expand in order to make the necessary additional room. By habit, one will break the proportion in the movements of these various tissues; for instance, the diaphragm may be depressed out of proportion with the movement of the ribs, or the ribs may be raised while the diaphragm moves but little. Breathing by use of the diaphragm chiefly is called *abdominal breathing*. When breathing is done mainly by the upward movement of the ribs, it is called *chest breathing*. Abdominal breathing is more common among men, and chest breathing among women. Either form, to the exclusion of the other, is hurtful, but chest breathing is much better, as it gives the lungs greater strength in the upper portions. Abdominal breathing should be avoided, as it leads to very bad results. A little practice will overcome any errors in breathing.

2. **Tight Clothing.** — Health cannot be perfect unless the lungs and other internal organs are given sufficient room. No tight clothing should be worn. Most cloth-

ing should be suspended from the shoulders, especially heavy clothing. Tight lacing of the waist is a very injurious practice; it compresses the lower portions of the thorax and reduces lung capacity, making it impossible for the lungs to take in sufficient air. Short breathing

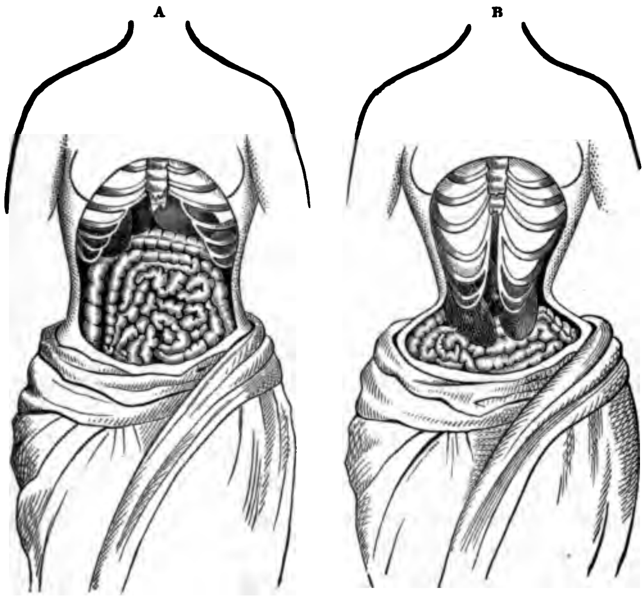


FIG. 44.

a, the natural position of the internal organs; *b*, when deformed by tight lacing. In this way the liver and the stomach have been forced downward, as seen in the cut.

and short life follow. Tight corsets also compress the abdominal organs, especially the stomach and liver. It is impossible for one to be healthy under these conditions. There can be no objection to the use of the corset, if it is not too tightly worn.

3. Obstructed Breathing.—This results in a lack of oxygen. When the stomach and intestines are too full

because of heavy eating, or gas, the size of the thorax is reduced, making it impossible for sufficient air to get into the lungs. From this, shortness of breath will be felt. Nature tries to meet the difficulty by rapid breathing, so as to carry more oxygen to the tissues. But this will give only temporary relief, as long as the fresh air has not room to get into the lungs. Shortness of breath is felt in some forms of heart disease, especially when the heart beats too slowly; also after serious bleeding, and when there is any obstruction of the larynx and trachea, as an excess of mucus; it is frequently a symptom of approaching heart failure.

4. **Exercise of Respiratory Organs.** — Muscular and breathing exercises are of great benefit to the organs of respiration. Arm, head, shoulder, and chest exercises should be taken each day. Whatever the occupation, one should keep the body erect. Leaning forward, backward, or to either side reduces the chest cavity at some point. Indoor life, working at desk or machine, or any work that requires the body to be bent, is injurious to the lungs. Many people work in a sitting posture, as pupils in school, shorthand writers, telephone operators, or type machine operators; the effect of this position should be overcome by several hours of exercise in the open air.

Breathing exercises should be carried on each day in the year. Have a suitable place in the open air, throw the shoulders well back, and with the head up, inhale slowly and deeply as long as possible; hold the air to the limit, and then exhale slowly, breathing only through the nose. Keep up this exercise for several minutes. Then take the same exercise while walking. This, kept up for a few minutes several times a day, will not only give the lungs capacity, but will prevent lung trouble and colds.

5. Adenoids. — Adenoids are peculiar growths of the upper pharynx at the opening of the nose. They look somewhat like a bunch of grapes. They are soft, spongy bodies, and usually appear in early childhood. Sometimes they are associated with the tonsils. Adenoids obstruct or even close the opening of the nose. This forces one to breathe through the mouth. Mouth breathing affects the growth of the upper jaw, making it somewhat narrow and pointed. Adenoids frequently close up the Eustachian tubes and cause deafness. In later life, the adenoids are usually absorbed, thus curing themselves, but the ill-shaped jaw and perhaps the impaired hearing will remain through life. They should be removed by a surgeon. It is well for all persons who breathe through the mouth to be examined for adenoids.

6. Asphyxia. — If the air is withheld from a person, great distress will follow. In a few seconds unconsciousness will appear, and the patient will make a great struggle for breath. Suffocation will follow after a minute or two; the blood will become venous, and the sufferer turn purple. Death will follow in a very few minutes if relief is not secured, and the person is said to be *asphyxiated*. Asphyxia is caused by the lack of oxygen. This may happen by preventing breathing, or by breathing air that does not have enough oxygen.

7. Artificial Respiration. — Even when breathing has ceased, it may be restored, and life saved by artificial means. There are three methods of artificial respiration: (1) By alternate contraction and expansion of the chest by pressure; this is done by forcibly compressing the ribs and the abdominal walls so as to reduce the capacity of the chest, forcing air out of the lungs; this act is followed by an immediate expansion of the chest, when the air rushes

into the lungs again. The contraction and expansion should occur from fifteen to eighteen times a minute, as often as a person breathes naturally. (2) After laying the patient on the ground with face downward, the operator should stand astride the patient, placing his hands around the lower part of the chest, and raising and lowering the body thereby. The weight of the body will contract the thorax when the patient is lifted, and expansion will follow as the patient is laid down again. In this way the air may be forced in and out of the lungs very much as in breathing. (3) A good way to induce artificial breathing is to lay the patient down on his back, with head somewhat lower than the body, fold the arms across the chest, then raise the folded arms with slightly upward motion until they are above the head. This raises the ribs and throws the chest open; air will rush into the lungs. Then gently bring the arms down again and exert considerable pressure upon chest, which will produce a forced expiration. Repeat this as often as one breathes; natural respiration will usually be restored. In addition to these movements, if the operator can think to stimulate the respiratory center, his efforts will be more effective. An assistant should grasp the tongue of the patient firmly between the thumb and fingers, using a handkerchief or napkin next to the tongue, and pull it forward; this will open the larynx and aid in stimulating the respiratory center.

The best method of artificial respiration is perhaps a combination of the first and third, but it requires at least two persons to operate it.

8. **Drowning.** — Treatment consists in removing the water from the lungs and producing artificial respiration. The patient should be turned on his face, and the operator should stand astride the body, with hands locked around

the lower part of the chest. He should raise and lower the body several times for a minute; this will force the water out of the lungs, and perhaps produce artificial respiration. No time should be lost. If this is not effective, the patient should be placed with face downward, and head and shoulders a little lower than the body. Press lightly upon the chest to force the water out of the lungs. As soon as this is done, perform artificial respiration by the first and the third method combined. The limbs should be kept warm by artificial means.

9. Death from Shock. — Shock is caused by passing larger impulses through the nerve centers than they are able to stand. Shock may arise from strong emotion, from an electric current, from an injury, or a surgical operation. Soon after a shock occurs, the patient may become unconscious. When the shock is not too great, artificial respiration will save life.

10. Alcohol and Respiration. — There are two important effects of alcohol upon respiration: (1) the effect upon the walls of the capillaries, the cells, and the lungs; (2) the extensive use of oxygen, which is taken from the tissues. The capillaries of the lungs, like all the others of the body, become permanently injured by the use of alcohol, and the air cells are affected so that oxygen will not pass through them easily. Alcohol also fills a portion of the air cells of the lungs, and affects other cells so that their work is imperfect.

When alcohol reaches the stomach, it is quickly absorbed and oxidized, and there is no trace of it left. One ounce of alcohol will require as much oxygen as one will get by natural breathing in two hours. Only a few drinks of whisky are sufficient to produce a narcotic effect through-

out the body. In this way drunkenness begins. The oxygen should have gone to the tissues, but they are deprived of it. Drunkenness is due to the fact that proper oxidation does not go on in the tissues, and the body is not able to remove the poisonous waste matter fast enough. This poison takes effect on the brain and on the great centers of the spinal cord, and if continued, will finally cause paralysis, and intellectual and moral death.

11. Smoke and Respiration. — The smoke of tobacco is especially hurtful to the delicate tissues. It irritates, produces a cough, and sometimes an inflammation. If tobacco smoke is inhaled, it is more injurious, because it is absorbed in the bronchi; this is one reason why cigarette smoking is so injurious. Breathing is further affected by the use of tobacco through its effect upon the nervous system, digestion, and circulation.

12. Rarefied Air. — The pressure of the air is equal on the surface and interior of the body, and the weight of the air is not felt. As we ascend a high mountain, the atmosphere becomes more rare and lighter. At the height of six miles there is scarcely enough oxygen in the air to sustain life at first. This reduced pressure of the body disturbs circulation, the head becomes dizzy, and fainting sometimes follows. The higher the altitude the purer, cooler, and less humid the air. For these reasons, mountainous countries are better for consumptives. The extra effort to obtain sufficient oxygen gives the weakened lung a useful exercise. In going into a deep well or into deep water for building a bridge, conditions are almost the reverse of those found in climbing a mountain. The effect of atmospheric pressure upon the arteries and veins is very great, and disturbs circulation.

On entering and leaving the caisson, movement must be so gradual that the blood vessels may have time to adjust themselves to the change of pressure. Ear drums are in danger, and nervous centers are sometimes overcome.

OUTLINE SUMMARY

1. *Abnormal Breathing*. 1. Abdominal — breathing mainly by use of diaphragm.
   2. Chest — breathing chiefly by raising ribs.
2. *Tight Clothing*. 1. Support — from the shoulders, not waist.
   2. Lacing of body — reduces lung capacity and disturbs circulation; compresses stomach and liver, and makes short breath.
3. *Obstructed Breathing*. 1. Causes — indigestion, distended stomach, overexertion, heart disease; short breath means short life.
   2. Deficiency of blood — hemorrhage, obstruction in breathing.
4. *Exercises of Respiratory Organs*. 1. Breathing exercises — of great value; state kinds.
   2. An erect chest — any leaning or bending of chest injurious.
5. *Adenoids*. 1. Definition — growths in upper pharynx at opening of nose.
   2. Effects — mouth breathing, elongated upper jaw, deafness.
6. *Asphyxia*. 1. Definition — an unconscious state due to lack of breath.
   2. Result — death due to a lack of oxygen.
7. *Artificial Respiration*. 1. Definition — forcing breathing by artificial means.
   2. Methods — three. Make statement.
8. *Drowning*. 1. Definition — asphyxia by water.
   2. Treatment — artificial respiration, stimulation.
9. *Death from Shock*. 1. Definition of shock — passing a larger nervous impulse than the center is able to stand.
   2. Cause — emotion, electric current, injury, surgical operation.
   3. Cure — artificial respiration and powerful nerve tonics.
10. *Alcohol and Respiration*. 1. Effects — two, (1) capillaries, cells and lungs; (2) rapid use of oxygen.
    2. Drunkenness — caused by depriving cells of sufficient oxygen.
11. *Tobacco and Respiration*. 1. Direct effects — irritates membranes and poisons tissues.
    2. Indirect effects — poisons system at large, through vital action.
12. *Rarefied Air*. 1. Reduced pressure — disturbs circulation, causes dizziness.
    2. Increased pressure — disturbs circulation, ruptures ear drums.

QUESTIONS

1. What is abdominal breathing?
2. What are the effects of tight lacing? Obstructed breathing?
3. What are adenoids? How are they cured?
4. What is asphyxia?
5. Give three methods of artificial respiration.
6. What are the effects of alcohol and tobacco on breathing?
7. What is the effect of rarefied air on breathing?

CHAPTER XXIX

VENTILATION

1. **Pure Air and Health.** — Pure air, like pure water, is seldom found in nature. By pure air is meant such air as is found in the open country in higher altitudes, free from dangerous odors and gases. Pure air contains oxygen, nitrogen, a small amount of carbon dioxide, and some moisture. Carbon dioxide is not very poisonous, but it displaces oxygen. It reduces the oxygen of pure air until it cannot sustain life.

Most gases are injurious to the tissues of the body; sewer gas, factory gases, the gases of decaying bodies, gas from lamps and poor stoves, the gases from many chemicals, and organic gases from the body, are all injurious.

Exhaled air is injurious if rebreathed, because of its carbon dioxide and poisonous organic substances; it is purified by mixing with a large body of pure air; its impurities are absorbed by water, or used by plants, or combined with other substances; the quantity is thus so reduced that it is harmless. Pure air is necessary to sustain life; if air is breathed over and over, the blood is not only loaded with poisons inhaled, but cannot throw off the poisons from the tissues. A double poisoning goes on

until the tissues are overcome and all vital functions impaired. The injury will finally become permanent, and even death may ensue. Schoolhouses, theaters, churches, all public buildings, and bedrooms should be flushed out with pure air once for each time used, even when well ventilated while used. The air in all rooms must be as pure as the air outside.

2. **Foul Air.** — Air is made foul by vapors, gases, and solid particles in the form of dust. Vapors and odors come from the body, rise from damp cellars, pits, decaying organic matter, and from the earth. Poisonous dust may come from the same sources, from factories, from filthy streets, and tenement houses. All such vapors, gases, germs, fumes, and dust should be scattered in larger volumes of pure air, or destroyed by deodorants and disinfectants.

3. **Moisture and Health.** — To be healthful, air must contain some moisture. Almost all air contains some moisture, as is seen in dew, or water deposited upon the sides of a tank of ice water. The amount of moisture needed for good health is determined somewhat by habit. If the air is too moist, it overtaxes the respiratory organs, and if too dry, it irritates the delicate membranes of the air passages and lungs. Rooms heated by stoves soon lose their moisture; if heated by steam radiators which allow the escape of some steam, they may become humid. These extremes have to be corrected, especially the former. Consumptives have to seek a climate of rare, dry, warm air.

4. **Dust and Disease in Air.** — Dust is composed of fine particles of earth, as sand, limestone, soil, hair, lint, carbon in smoke and soot, scales from the skin, and dry waste

matter from the bodies of animals, and no air is free from it. Some of this dust is so fine that it cannot be seen by the naked eye. Besides dust, air contains bacteria.

Any dust is injurious; coarse dust irritates the delicate membranes of the respiratory tract, alimentary tract, and eyes. In times of drought the air is filled with very fine dust, which affects people like a cold. The air has to be washed with rains to be pure. Means should be adopted to protect delicate structures against dust, and protect the body against disease germs; the former can be done by screening, and the latter by disinfection.

5. Ventilation. — Ventilation is a process of changing the air in a building by forcing bad air out and fresh air in; perfect ventilation will keep the air within a room as pure as the air outside, and just warm enough to be healthful. There are, therefore, two ends to be considered in all systems of ventilation, namely, (1) purity, and (2) temperature. The former is attained by circulating the atmosphere, and the latter by increasing or decreasing the heat to the proper degree; each process can be made to aid the other.

A few facts of physics aid in the work. Cold air is heavier, and descends, forcing up the lighter warm air. Impure air is heavier than pure air, and impure air seeks a lower level. If it is impure and heated, it will be forced up until it becomes cool, and then settle down to some low place. By diffusion, warm and cold air, and pure and impure air, pass through the same opening at the same time, but in opposite directions.

6. Methods of Ventilation. — Whatever the method, pure air must be brought in, uniformly distributed and heated, and foul air forced out. Naturally, there is some

ventilation in almost any room, as it is almost impossible to build an air-tight room; with the opening and closing of doors and windows, and heating, there is always some ventilation. If there are but few persons in a room, this ventilation may be sufficient, especially in the country. Good ventilation does not permit a current of air to be felt in a room, and good heating does not permit one part of the body to be warm while another part is cold.

A good plan for ventilating an ordinary room is to open the windows at the top; the warm air at the ceiling will pass out, and fresh air will enter at the top and at the opening between the sash. There are many forms of this plan, as raising the lower sash of the window and fitting a board into the opening so as to close it. The space between the sash serves as an exit for warm air; an opening for fresh air should be made in some other part of the room. Another form of the plan is to have an opening for fresh air under the stove or grate, or near the heater, so as to heat the air as it enters, and make a place for foul air to escape by opening a window at the top, or a flue near the ceiling. In a room heated by hot air, the register will ventilate as it heats, if the warm air brought in is pure before heating, and an opening is made for the escape of foul air, as before. In cold weather the air will rush in through a small opening with great force; a large opening is not needed, usually. When the weather is warm, a much larger opening is needed to ventilate, as there is no current; this fact must not be overlooked in any plan of ventilating.

The ventilation of churches, theaters, and assembly rooms is more difficult. In warm weather, windows may be opened as in any other building; but in cold weather fresh air should enter through or near the hot-air registers, if possible, and the foul air pass out at an opening in the center of the ceiling. If heated by steam or hot water.

the fresh-air opening should be made under or near the radiators, so as to heat the air as it enters. Cold-air shafts can be made in the wall like a chimney, supplied with a register, and opened so as to heat the air as it enters, and thus prevent any draft whatever. In no case should large windows be opened when an assembly room is heated, except by tilting the sash on its hinges so as to throw the current of fresh air to the ceiling first; then it will become heated before it descends. The opening for fresh air should be near the place of heat, and the exit for foul air at the farthest point from it.

Forced circulation has done much good in large buildings; warm, pure air is forced in by rotary fans, and foul air passes out through a ventilator in the ceiling, or is forced out by a fan, and a uniform temperature maintained. Another way is to expel the foul air by rotary fans, and admit fresh, warm air through many small openings near the floor, which will prevent drafts, while uniform heat and purity of air are maintained. In case of forced ventilation, air is sometimes filtered by passing it through partitions in the air shaft so as to break the current and cause dust to settle; or by passing it through layers of cotton to arrest the particles of dust. Moisture is added when needed. Again, air may be washed to cleanse it of dust very much as it is washed by rain or snow.

Schoolrooms should have special attention; ventilation should be almost perfect; pure air is a necessity. If there are no modern means for heating and ventilating, a thoughtful teacher can do it by some of the simpler plans suggested. It is well every two or three hours to throw open the windows for a few minutes, and flood the room with good air. About one third of all deaths come from consumption and other diseases of the respiratory tract. Proper ventilation will prevent much of this.

7. Drafts. — No one should ever have a cold if it can be prevented. Persons used to indoor life, or naturally delicate, should be very careful, as it is easy for them to take cold. Colds are usually contracted by suddenly reducing the temperature of the body. If bodily resistance is good, temperature may be quickly restored; otherwise, a cold will follow. Fresh air is important, but it should be had without a draft. When the body is overheated, fatigued, or naturally delicate, sitting in a draft or in a cold room will quickly give one a cold; long-continued, severe cold, or a strong, cold wind against one portion of the body will produce a cold. A cold usually affects the mucous membrane of the chest and head, but may affect the digestive organs, the liver, and the nerves. It may center upon one or more organs, when it is said to "settle" there, causing an organ to inflame, or a gland to break down. Diarrhea or dysentery may follow a cold in the digestive tract. If one exercises while in a draft, he will seldom take cold, but the best way is to keep free of drafts, and not take the risk. One cold may prepare the body for consumption, or some other dangerous disease.

8. The Sick Room. — A room occupied by the sick should be well ventilated all the time, because the patient needs a surplus of oxygen. The air should circulate freely to remove disease germs and any unpleasant odors. The patient should not be subjected to hurtful gases or the odor of medicines; he should not be exposed to drafts or dust. The room should be flooded with sunlight several times a day, or have gentle rays all day.

9. The Bedroom. — A bedroom should be on the second floor, or higher, to relieve it of ground moisture or cellar gas; it should be dry, clean, and ventilated day and night.

A bedroom should not be used for other purposes, and should be as cool as external air. While no one should sleep in a draft, windows in a bedroom should be wide open all night. The sleeper should be made comfortable with more bed clothing, if necessary, but breathe pure, cold air all night. An open grate is a good means of ventilation, but it is not sufficient during the night. It is well to let beds remain open during the day to ventilate. All bedding should have a good sun bath and airing every day, if possible.

10. Diseases of Respiration. — The chief diseases of the respiratory tract are consumption, diphtheria, pneumonia, asthma, catarrh, bronchitis, and temporary troubles due to bad air, bad breathing, irritation, or infection. *Consumption* is an infection due to a germ which is inhaled; it attacks the lung or other tissues of the respiratory tract. The germ may enter the blood and attack any tissue of the body. Pure air, deep breathing, and strong resistance are the chief means to overcome it. Most cases of consumption are curable, if taken in time. Nearly one half of the human race have been infected with consumption, and the majority of cases are due to bad breathing. The lungs can throw off the germs, if strong.

Diphtheria and *pneumonia* are infections caused by germs. The latter is seldom taken except when the lungs are obstructed with mucus, or irritated; both diseases need the immediate attention of a physician. *Asthma* is a congested condition of the bronchial tubes; it is affected by seasons, is very disagreeable, and hard to cure. Bad breathing aids it. *Bronchitis* is an inflammation of the bronchial tubes, and may be caused by irritation, obstruction, or germs; if breathing is good, it will go far to prevent it. Tool grinders, stone cutters, steel workers, potters,

miners, millers, hemp workers, and threshers are liable to lung troubles from dust; workers with quicksilver, phosphorus, and gases are subject to poison from these substances.

Sewer gas is very harmful, not only for its offensive odors, but because it comes from a current in which almost all known bacteria may be found. Sewer gas is also very penetrating.

Malaria comes from stagnant water, and is introduced by a species of mosquito which lives in such water in the first period of its existence. Malaria can be prevented by draining the swamp and giving fresh air access to the place.

Cellar air is dangerous, because most cellars do not get sunlight, pure air, and heat; they are good places for bacteria to grow, foul odors to form, and moisture to collect. Bacteria find their way up through the house.

Night air was formerly supposed to be laden with germs, and more injurious than air of the daytime, and early morning air was supposed to be best. Owing to the action of the light and heat of the sun, exactly the reverse is true. The purest air is usually that of the early evening. The early morning air is colder, but usually not quite so pure; but a wind may reverse this in a short time.

Coal gas is carbon oxide and is very dangerous; it is the chief element of illuminating gas; it also escapes from an ill-fitting coal stove; if one should inhale enough of it when asleep, he will never wake. The treatment is fresh air and artificial respiration.

Lamp gas is produced by a burning lamp or candle; also by fires in grate and stove, but it usually escapes through the chimney. All these are large users of oxygen, and in making the air of the room impure.

OUTLINE SUMMARY

1. *Pure Air and Health.* 1. Composition of pure air — oxygen, nitrogen, small amount of carbon dioxide, and some moisture.
   2. Injurious gases — sewer gas, gas of putrefaction, carbon monoxide, gases from bad lamps and stoves, gases from some chemicals, and organic gases.
2. *Foul Air.* 1. How produced — by vapors, gases, dust, and other foreign substances.
   2. How purify — scatter in large volumes of pure air; disinfectants.
3. *Moisture and Health.* 1. Amount — some moisture is necessary.
   2. Extremes — too much moisture overtaxes the respiratory organs and too little irritates.
4. *Dust and Disease in Air.* 1. Dust — Make statement.
   2. Germs — those of many diseases are in the air..
5. *Ventilation.* 1. Ends — purity and correct temperature.
   2. Facts of physics — Make statement.
6. *Method of Ventilation.* 1. Drafts — avoid drafts, and heat air evenly.
   2. Kinds — Make statements of methods.
7. *Drafts.* 1. Effects — lower temperature of body, and a "cold."
   2. Disease — one "cold" may prepare the system for consumption.
8. *The Sick Room.* 1. Ventilation — should be perfect.
   2. Sunlight — flood with sunlight several times a day.
9. *The Bedroom.* 1. Location — second floor, or higher.
   2. Ventilation — room should not be used for other purposes, and windows should stand open.
10. *Diseases of Respiration.* 1. Names — Make statement.
    2. Causes — germs, dust, poisons, and colds are chief.
    3. Remedy — nothing so good as an abundance of pure air.
    4. Incidental troubles — Make statement.

QUESTIONS

1. What is the composition of air? What is foul air?
2. What is the effect of moisture in the air? How much moisture is necessary?
3. Why must houses be ventilated?
4. What methods are employed to ventilate buildings? How should a bedroom be ventilated?
5. How ventilate a sick room?
6. What are the diseases of the respiratory tract?

CHAPTER XXX

THE HEAT OF THE BODY

1. **Animal Heat.** — The temperature of the body in health is constant, being the same in all seasons. The normal temperature of the body is 98.5 degrees F. It is produced by oxidation, which goes on in every cell in the body. The temperature of the body is almost uniform, although much more heat is produced in some parts than others; most sugar is oxidized in the liver, and most fat in the lungs, but the excess of heat at these points is carried to other parts of the body by the blood. Perspiration keeps down the temperature when in great heat, and oxidation keeps it up when in the cold. In disease, the temperature may run up several degrees above, or may drop below normal.

2. **Fever.** — Fever is the term applied to bodily temperature above normal, and chill is the term applied when it drops below normal. One degree of temperature either way is very noticeable, and makes the body uncomfortable. A fever or a chill is caused by poison or nervous action, and is a symptom of illness. A fever of 104 degrees is high, and 105 degrees of continued fever is nearly always fatal. Fever may strike in and leave the skin pale and cold; a chill may follow, while internally there may be a raging fever. In old age, or when the heart is weak, the sensation of cold is more pronounced, because there is a lack of blood in the capillaries.

3. **Regulation of Heat.** — The amount of heat in the body varies at different times, and no two bodies produce the same amount of heat. The production of heat depends

upon (1) the amount of food, (2) the kind of food, and (3) the amount of oxygen taken into the system. Heat is lost (1) in the breath, (2) in coming in contact with the air, and (3) in being converted into energy.

In the summer season and in warm countries, people eat less food; they eat also foods that do not produce so much heat. In the cold seasons, people eat larger quantities of heat-making food. The amount of oxygen entering the body is regulated somewhat by work and exercise. The deep breathing caused by manual labor sends much more oxygen to the cells. Nature controls the amount of heat given off. With the rise of temperature in the body, more blood is carried to the capillaries and comes in contact with the air. If the amount of heat in the body is below normal, the capillaries contract, so that less blood will go to the surface, and less heat be lost. These steps, in regulating the body's heat, are usually unnoticed. If the body is very warm, or the temperature of the air is higher than that of the body, the sweat glands are thrown open as the heat increases. In this way the temperature is lowered as fast as it rises. The heat of the body is consumed in changing the water of perspiration to vapor; just as in a boiling teakettle the temperature does not increase however hot the fire. Whenever pressure is great in any part of the body, and affects the circulation, temperature goes down. Tight garters may cause cold feet, and a tight corset may make the whole body feel colder.

4. Moisture in the Atmosphere.—In the summer, perspiration will not evaporate from the skin if there is much moisture in the air, and much of the body's heat will be retained; under this condition, the air seems sultry. When the air is dry at a temperature of 90, it is not so

oppressive as when humid and 10 or 20 degrees cooler. In the winter, moist air seems much colder than dry air, because moist air is a much better conductor of heat than dry air is. A damp wind takes up the heat of the body and makes it seem much colder. A moist wind is very penetrating because of this property. A moist wind will seem colder than dry wind, even when 10 degrees warmer than the dry wind.

5. **Clothing.** — Clothing is used to aid the body in its effort to regulate heat. Clothing prevents the loss of heat by protecting the body, and in some cases aids the body to keep out heat. In general, clothing that is a good conductor of heat is best for summer. The poorest conductor of heat is wool; fur and silk stand next, cotton next, while linen is the best conductor. Clothing of wool and fur should be worn in the winter, and cotton and linen in the summer. Dryness in clothing is an important factor. If the meshes of the garment are full of dry air, it is a better non-conductor of heat. Damp clothing should never be worn in either winter or summer, because of the effect of moisture on the skin.

Woolen clothes of various kinds, being poor conductors of heat, are ideal for winter wear. In the sudden changes of temperature it better retains the heat of the body, and gives the capillaries time to adjust themselves. Woolen clothes should never be worn next to the skin. They are poor for summer wear, because they prevent the escape of the extra heat. In case the heat of the air is greater than that of the body, woolen clothing will prevent heat from entering; it is then cooler than linen. This is seen in the case of men who work in warm factories and wear flannel shirts, finding them cooler than linen. For ordinary wear, however, woolen clothing is unsuited for the

summer. People who make much heat, and are otherwise healthy, should not wear heavy garments next to the skin, either in winter or summer. An exception to this rule may be made of people who have poor heart action, or are well advanced in years.

Fur is a poor conductor of heat, and therefore makes a comfortable wrap, especially for the shoulders, neck, and hands. A fur coat is the best of all for women who are subjected to sudden changes of temperature, or those whose heart action is not good.

Silk, being a poor conductor of heat, makes an ideal garment for light wear; it is good for lining heavy garments like overcoats and cloaks. It is soft, pliable, and light, and makes comfortable garments where no great amount of heat is required.

Cotton is more generally used for clothing than any other material. It is a fairly good conductor of heat, and therefore not good for sudden changes and great extremes of temperature. It is also porous, and will not protect the body from a strong, moist wind. It is soft, and for lighter garments it is an excellent material. Except in unusual cases, it makes better under-garments than wool or silk.

Linen is the best conductor of heat, and is therefore a good fabric for summer. It is excellent for under-garments as well as heavier outer garments. Its durability and the readiness with which it may be laundered render it a most useful fabric. It is almost universally used by poor and rich alike. It is a poor protection against cold, and cannot be worn where there are sudden changes.

Since the air itself is a poor conductor of heat, loosely woven cloth is warmer than tightly woven cloth. Most garments are warmer when they contain a larger amount of air. This is one reason why furs are so warm. Loosely fitting clothing is therefore warmer than clothing of tight fit.

Color is an important item in clothing. Black cloth takes up much more heat than white goods. For this reason, light-colored or white clothes are much better for summer, and black is better for winter.

All parts of the body do not have the same power to resist cold. Extremities, like the face, hands, and feet, do not need much clothing, and seldom have to be protected regularly. The feet have to be protected more against roughness of the ground than against cold. Such parts as the chest, abdomen, neck, and back need protection. In most cases too much clothing is worn, and the body is too warm all the year. Again, there should be no damp or wet clothing used to cover certain parts of the body while the rest of the clothing is dry. Wet feet, for instance, are very dangerous. Dampness causes cold by evaporation of the water in the clothing.

Because of the great activity of the feet, they perspire freely. Stockings and soles of shoes are soon moistened, if not wet, and make the feet feel cold. This may be corrected somewhat by wearing thin stockings of material that readily absorbs moisture, and shoes large enough to admit of good ventilation. Shoes and stockings should be dried thoroughly, and in case of unusual perspiration an inner shoe sole may be used to advantage. The effect of a cold foot bath each morning is to keep the feet warm throughout the day; the reaction brings the blood to the capillaries, and thereby makes the feet warmer. The same principle holds good for the whole body.

Paper, being impervious to air, will protect one against cold. A paper spread between bed clothes is equal to an additional comfort.

The amount of clothing worn should be governed by one's occupation. One should dress to suit the place in which he works. People who work indoors should dress lightly,

and on going out protect the body by additional clothing. If one's work is out in the open air, his regular clothing should be suited to the open air, and on entering the house the extra clothing should be removed, or a lighter suit put on.

All clothing worn in the daytime should be removed and well ventilated at night. Sheets and all clothing worn next to the body should be frequently changed, laundered, disinfected, and ventilated before using again. Soiled clothing should never be worn next to the skin, because impurities are absorbed.

6. Results of lowering and of raising Temperature of Body. — Excessive cold produces a state of numbness in which sensation is partly lost, and great suffering follows. If the body continues cold, breathing and circulation are diminished, and drowsiness follows, suffering ceases, a pleasing sensation of rest takes possession, and a painless death ensues. One will seldom freeze if he keeps moving, but to lie down to sleep when drowsiness appears is fatal. As long as the heart beats, there is a chance of recovery. Heat in some form should be applied, and artificial respiration done.

The effect of raising the temperature is exactly the opposite. Breathing and circulation are increased, and mental excitement follows. If heat continues to increase, delirium appears, and finally death ensues. Treatment consists in reducing temperature and giving some medicine to soothe and relax. One can work in a temperature of 150 degrees for a short time if perspiration is free, but any temperature above 110 degrees is dangerous.

7. Heating Houses. — Clothing alone is not sufficient to give the body uniform heat; rooms, shops, and offices must be heated in winter and cooled in summer. The

temperature of greatest comfort to the body is about 70 degrees. Living rooms, churches, hospitals, and offices should have a uniform temperature of about 70 degrees all the year.

As a rule, people live too warm, especially in winter; this is the cause of much catarrh, bronchitis, and consumption. Bedrooms should be heated only enough to keep them dry, and when in use should be heated very little, if any; an exception may be made in case of old people and invalids.

8. **Beds.** — In making good beds, heat is an important item. All the principles of the heat of clothing apply to beds. With feathers, a poor conductor of heat, on one side, and cotton bed clothing on the other, the body is unequally heated. A good mattress, with good springs, and good clean linens and clothing, makes the best bed for an equal distribution of heat. One should not put on too much bed clothing; later, when warm and asleep, he is liable to throw off clothing and take cold. Sleeping with the head covered is very injurious. Bed clothing should be well wrapped about the neck and chest to protect them, but should not be heavy.

9. **Frostbite.** — Those parts of the body farthest from the heart, exposed, and with poor circulation, as toes, fingers, and ears, are liable to very slight freezing, called frostbite. When this state appears, the circulation in the part ceases; there is a pricking sensation, swelling, and a bluish color; finally, the part becomes pale and numb. There is freezing of a portion of the water that comes out of the cells. If circulation is not restored, the part will die and break off. The important thing in treating a frostbite is to keep all heat away from the part; it must be covered with snow, shaved ice, or cloths dipped

in ice water; it may be put in ice water, and rubbed while under the water; this is in order to restore circulation slowly and gradually in the frostbitten tissue. Nature alone can do this. Soon color will return if the part is properly treated. If it should come in contact with heat, the rapid return to normal conditions will destroy the delicate structure of cells. In case of freezing, the treatment is very much the same. The life of the part depends upon slowly thawing it out. No warmth must be applied to a frozen part.

10. Sunstroke. — Excessive heat may produce a sudden attack of unconsciousness called sunstroke. It is very depressing, and often fatal. The unconsciousness is long, and accompanied by great weakness. It may be caused by heat of the sun, or by artificial heat, as the heat of a furnace or factory. It is more likely to occur with weak persons, those used to alcoholic drinks, and those who sleep in poorly ventilated rooms.

The patient should be laid upon his back in a cool place, with plenty of fresh air; his clothes should be loosened, head raised, breathing stimulated, heart sustained, temperature reduced with ice and cold water, and if necessary, artificial respiration done. Cold applications to the head are important. The patient should remain quiet for many weeks. To prevent it, use no alcohol, take plenty of sleep in a cool, well-ventilated bedroom, take a daily bath to keep the skin in good order, wear loose clothing, drink but little water at meals, keep digestion good, and the head cool.

11. Burns. — Prompt treatment is necessary. Exclude the air, and soothe the part by use of cold water temporarily; then apply linseed oil and limewater mixed in equal parts, or pure leaf lard, or a soft mixture of lard and flour, or white of egg, or a heavy lather of soap.

In case of burning clothing, throw the person to the floor to keep the flames away from face; quickly roll patient in a blanket to smother the flames, and as soon as possible cut the clothing off; if clothing sticks, do not jerk it off, but remove gently. As the shock is great, keep the patient quiet and give a stimulant. If the burn is severe, call a physician.

A burn from acid should be quickly washed with water, then treated with some alkali like soda and water. A burn caused by an alkali should be treated with an acid.

12. Effect of Alcohol on Heat. — Primarily, the oxidation of alcohol produces heat, but the loss of heat is greater than the production. At first, the body seems to be warmed by the action of alcohol, but this sensation is caused by heat that is rapidly passing away. Alcohol causes loss in two ways: (1) by dilating the blood vessels of the skin, more heat comes in contact with the air and is rapidly lost; and (2) in the depression that follows. Additional heat must be supplied to prevent or overcome the collapse.

Every drinker knows well the feeling when his "whisky is dying" within him, and how much heat is required to keep him warm. Alcohol lessens the heat of the body by disturbing the circulation and absorption; it also destroys nerve force, which indirectly prevents the making of natural heat.

13. Tobacco and Heat. — The poison of tobacco interferes with oxidation, and therefore prevents the making of heat. Its soothing effect tends to diminish rather than increase the body's energy. But its indirect effects upon heat, through the circulatory, nervous, and respiratory system, are even worse than the direct effect.

14. Drug Habit and Heat. — Any drug habit naturally lessens the body's power to produce heat, or to retain it, chiefly through the action of the drug upon the nerves, and indirectly upon circulation, breathing, and absorption. When the production of heat is diminished, the whole system suffers.

OUTLINE SUMMARY

1. *Animal Heat.* 1. Normal — constant at 98½ degrees F.
   2. Distribution — uniform.
2. *Fever.* 1. Definition — temperature above normal.
   2. Amount — 104 degrees is high, and 105 degrees dangerous.
3. *Regulation of Heat.* 1. Production — by (1) amount of food, (2) kind of food, and (3) amount of oxygen.
   2. Loss — by (1) the breath, (2) heating the body, and (3) being converted into energy.
4. *Moisture in the Atmosphere.* 1. Warm atmosphere — dry, warm air is not so oppressive.
   2. Cold atmosphere — dry, cold air does not seem so cold as damp air at same temperature.
5. *Clothing.* 1. Conductors of heat — linen and cotton; summer.
   2. Non-conductors — wool, fur, and silk; winter.
   3. Color — black cloth takes up more heat; it is best for winter.
6. *Results of lowering and of raising Temperature of Body.* 1. Extreme cold — causes numbness, loss of sensation, and death.
   2. Extreme heat — causes, at first increased circulation and mental excitement, then delirium and death.
7. *Heat of Houses.* 1. Temperature — about 70 degrees.
   2. Uniformity — temperature should be uniform throughout a house.
8. *Beds.* 1. Equal heat — body in bed should have uniform temperature.
   2. Amount — one should sleep as cold as is comfortable.
9. *Frostbite.* 1. Symptoms — pricking sensation, swelling, bluish color, then pale and numb.
   2. Treatment — keep all heat away; cover part with snow, shaved ice, or ice water; heat must return slowly.
10. *Sunstroke.* 1. Cause — excessive heat.
    2. Treatment — treat all conditions.
11. *Burns.* 1. Temperature — 212 degrees will burn to crisp.
    2. Treatment. Make statement of remedies.
12. *Effect of Alcohol on Heat.* 1. First effect — increases amount of heat.
    2. Loss of heat — by (1) dilating capillaries, and (2) depression.

13. *Tobacco and Heat.* 1. Poison — retards production of heat. 2. Soothing effect — diminishes heat.
14. *Drug Habit.* 1. Poison — lessens body's power to make heat. 2. Vitality — lessens power to retain it.

QUESTIONS

1. What is the normal temperature of the body?
2. What is fever? How high may it go?
3. How is the temperature of the body regulated?
4. What are the general effects of weight, color, material of clothing?
5. What are the effects of extremes of heat and cold?
6. What should be the temperature in ordinary houses?
7. What should be the temperature of beds?
8. How should frostbite be treated?
9. How treat a case of sunstroke?
10. How should a burn be treated?
11. How does alcohol affect the amount of heat in the body?

CHAPTER XXXI

THE SECRETORY SYSTEM — THE SKIN, AND SIMILAR MEMBRANES

1. The Secretory System. — The secretory system includes all organs that extract materials from the blood. The terms *secretion* and *excretion* have both a general and a particular meaning. A *secretion* in its broadest sense is anything extracted from the blood; in its narrower sense it includes only those things extracted for the use of the body, as saliva, gastric juice, or synovia; such things are true secretions. An *excretion* in its broadest sense is anything discharged by a gland, as saliva, perspiration, or gastric juice; in the strict sense, an excretion is a waste product, and thrown off that the body may get rid of it; carbon dioxide, perspiration, urea, and some forms of mucus are true excretions. The principal secretory glands have been described in connection with other systems, as

the salivary, gastric, and lymphatic glands. The principal excretory organs are the ***skin***, the ***kidneys***, and the ***liver***. The liver has both a secretory and excretory function.

The chief waste products of oxidation are carbon dioxide, water, and urea. The lungs throw off most of the carbon dioxide, the skin most of the waste water, and the kidneys most of the urea.

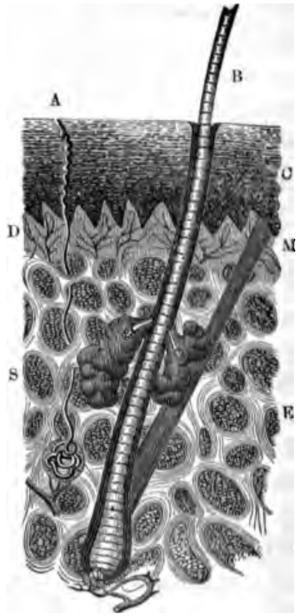


FIG. 45. — Diagrammatic section of the skin.

C, **epidermis;** ***D*** **and all below is dermis. At** ***D*** **papillæ are seen;** ***B***, **a hair;** ***A***, **duct of sweat gland;** ***M***, **muscle fiber;** ***E***, **fat;** ***S***, **sebaceous gland.**

2. The Coverings of the Body. — The coverings of the body are the skin, mucous membrane, and serous membrane. These membranes are very much alike in structure, but differ in function. The skin is the outer covering of the body, the mucous membrane an inner covering of organs exposed to air, and the serous membrane an inner covering of organs not exposed to air.

3. Skin. — The skin is made up of two layers; the inner layer is the true skin, called the dermis, or cutis; the outer layer is called the cuticle, epidermis, or scarf skin. The skin has four appendages: (1) oil glands, (2) sweat glands, (3) hair, and (4) nails. The skin is elastic and fits perfectly. Its use is to protect the structures, vessels, and nerves beneath, and to aid in the work of excretion. For good health it is one of the most important organs in the body.

4. **The Epidermis.** — The epidermis varies in thickness, being thickest usually on the soles of the feet and palms of the hands. It has neither blood vessels nor nerves. In general, there are two layers, the outer one having hard, flat, transparent cells that are constantly dropping off, as in dandruff or chapped hands. The inner layer has softer, rounded cells that contain coloring matter called pigment; this pigment makes the different colors seen in the various races, and the changes of tint upon exposure to light, as freckles and sunburn. The epidermis protects the true skin, and prevents the rapid escape of needed heat and water from the body.

5. **The Dermis.** — The dermis has two layers, an outer one, called the *papillary*, and an inner, called the *corium*. The papillary layer has many small projections, called *papillæ*, which contain the ends of nerves and blood vessels. In the hands they appear in rows. The corium is a thick, dense, elastic layer, out of which, in some animals, leather is made; it has many small bundles of fibers and muscles, and contains many small depressions or openings which are occupied by globules of fat, hair follicles, oil glands, and sweat glands.

6. **Muscles of the Skin.** — The muscles contract when cold, and form projections known as "gooseflesh." In cold weather these muscles contract, and make the hair of horses and other animals stand out. They enable a dog to make the hair on his back stand up when he is angry, and a hog to raise his "bristles"; they make a boy's hair stand on end when he sees a ghost. These muscles give the skin a delicate motion of its own, and aid the glands of the skin in their work.

7. **The Functions of the Skin.** — Each layer of the skin has its own function; but taking them together, the skin

has four functions: (1) to regulate the escape of heat and water; (2) to protect the vessels, nerves, and deli-

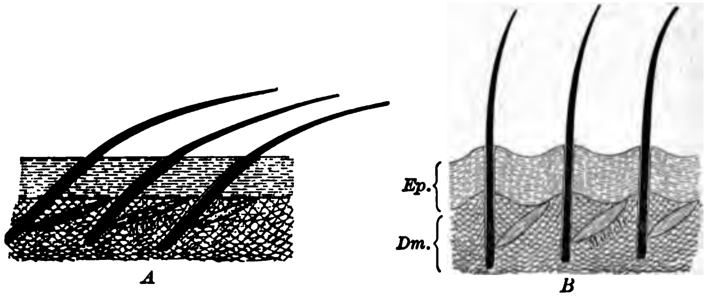


FIG. 46.—Diagram showing at *A* the hairs lying down and the muscles at rest. At *B* the muscles have contracted, pulling the hairs up straight, thus making the coat much thicker and warmer.

cate structures beneath; (3) to furnish a base for its secretory glands and fat globules; and (4) to excrete waste of the body.

8. Glands. — The two glands of the skin are the sweat glands and the oil glands. The structure just beneath the skin contains, usually, a large quantity of fat. The sweat glands originate in this cellular tissue beneath the skin. They are very small tubes that consist of a coil, with which they begin, and a shaft or body. The coil is beneath the corium among the globules of fat. The shaft passes through the skin in an irregular course, its external openings being the pores of the skin. The sweat glands are in contact with the blood vessels; they are the main drain pipes through which the waste water of the system is drawn off. In some form this water, laden with waste material, is escaping all the time. If one is warm enough, it passes off in the form of water; it is then called *visible perspiration;* if heat is not above normal, this water is vaporized, and passes off in the form of vapor, called invis-

ible perspiration. In either form it leaves most of its impurities in the pores of the skin.

The oil glands are groups of small sacs either in the corium or beneath it, having connection with the fat globules, vessels, and nerves. They secrete an oil which keeps the skin in order, and gives it a beautiful, glossy surface. Each oil gland is provided with a duct that empties upon the surface of the skin or into a hair follicle. They oil the hair as they do the skin; the amount they give the hair is sufficient without the use of hair oil. At the mouth of the ducts oil will collect, gather dust and soot, and harden, making spots sometimes called "blackheads"; they are not worms, as sometimes supposed, but merely a mass of oily material which can be removed with a little pressure, or with a flesh brush, soap, and warm water.

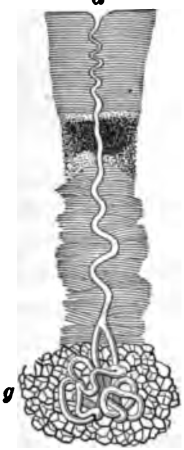


FIG. 47. — Sweat gland, with duct.
d, duct; *g*, gland.

9. Modified Forms of the Skin. — The modified forms of the skin are the nails and hair; they are usually described as appendages of the skin. Hair serves for protection and ornament, while nails aid in work and locomotion.

10. Nails. — Nails are similar to feathers, scales, claws, hoofs, and horns of lower animals. Nails are folded, modified epidermis. The nail grows by addition of new cells at the root, and beneath. The nail has two layers, an outer one, hard and horny, and a lower one, soft and sensitive. If a nail is crushed or torn off, a new nail will form if the root and matrix beneath are not injured. The entire nail is renewed about four times in a year.

11. Hair. — Hair has three layers: (1) the cortex, (2) fibrous layer, and (3) the medulla or pith; it has three parts: (1) root, (2) shaft, and (3) point. The cortex or outer layer is made up of hard, flat cells that overlap like the shingles of a roof. The fibrous layer is composed of long cells that contain pigment which gives the hair its color. The hair follicle is a little bag of epidermis dipping down into or through the true skin. The root of the hair fits into the follicle, which contains also a bulb that supplies the hair with nourishment, and makes a new hair when the old one is pulled out. If the bulb is destroyed, a new hair cannot grow. The bulb can be destroyed by strong chemicals, by electricity, or by being torn out. In case of baldness, the germ or bulb perishes. Hair turns gray because the pigment matter is absorbed and air takes its place. Great anxiety, distress, and illness hasten the time of gray hair. Baldness is usually due to a heated scalp, or may be inherited. Hair grows at the root end, and may become five or six feet long.

12. Mucous Membrane. — Mucous membrane lines all parts of the body that have an external opening, or that connect with a duct or tract that opens upon the surface of the body, excepting the pores. It lines the entire alimentary canal, all the ducts of organs that empty into it, and the entire respiratory system. When all this is put together, it will be seen how extensive this membrane is, and what a wonderful work it does. It is composed of two layers, the *epithelial* and the *serous;* the epithelial layer has no vessels, and generally no nerves. The serous layer has nerves, vessels, and glands, as the mucous, gastric, and intestinal. Mucous membrane protects the delicate structures from the air, and its mucus aids in protection against gases and solids.

13. Serous Membrane. — The abdomen is lined with a serous membrane called the peritoneum. When the membrane is inflamed, the disease is called *peritonitis*. The membrane is reflected upon the stomach, liver, intestines, and all other abdominal organs lining or covering them, and forming a closed sac. The thorax is lined with a serous membrane called the pleura; when this membrane is inflamed, the disease is called *pleurisy*. The membrane covers the heart and lungs, and lines the pericardium and chest wall ; it lines cavities of the brain, blood vessels, lymphatics, the inner ear, synovial surfaces, and the chambers of the heart.

In structure it very closely resembles mucous membrane; it has an outer layer of cells called *endothelium*, and a *fibrous* membrane beneath. The outer layer has no blood vessels or nerves, but the serous membrane is supplied with blood vessels and nerves. The cells of the outer layer are very smooth, flattened, and lubricated with serous fluid, giving it a very even, shining surface. Its chief function is to prevent friction, thereby enabling organs or surfaces to glide smoothly upon each other without irritation, and to allow fluids to move in their channels without causing inflammation. The membrane is very easily irritated by foreign or rough substances or air.

OUTLINE SUMMARY

1. *The Secretory System.* 1. Materials — secretions and excretions.
   2. Definition — secretion? excretion?
   3. Glands — secretory: salivary, gastric, and lymphatics; excretory: skin, kidneys, and liver.
2. *Coverings of the Body.* 1. Membranes — skin, mucous membrane, and serous membrane.
   2. Location. Make statement.
3. *The Skin.* 1. Layers — two, the dermis and epidermis. Other names.
   2. Appendages — four: oil glands, sweat glands, hair, and nails.

4. *The Epidermis.* 1. Description — epithelial cells, no blood vessels or nerves.
   2. Layers — two: outer, flat cells; inner, round cells and pigments.
   3. Uses — prevents escape of heat and water; protects dermis.
5. *The Dermis or Cutis Vera.* 1. Layers — two, the papillary and corium.
   2. Contents — bundles of fibers, muscles, and glands.
6. *Muscles of the Skin.* 1. Contraction — "gooseflesh," and hairs "stand on end."
   2. Use — to afford the skin a motion of its own.
7. *The Functions of the Skin.* 1. Separate function — each layer has its own function.
   2. General functions — four. Make statement.
8. *Glands.* 1. Sweat glands — excretory; beneath skin, a coil and a shaft.
   2. Oil glands — small sacs, secretory; empty upon the skin, or into a hair follicle.
9. *Modified Forms of Skin.* 1. Hair — used for protection and ornament.
   2. Nails — aid in work and locomotion.
10. *Nails.* 1. Similar forms — feathers, scales, claws, hoofs, bills, and horn.
    2. Parts — root, body, edge; tissue below is the matrix.
11. *Hair.* 1. Layers — three, the cortex, fibrous layer, medulla.
    2. Parts — root, shaft, and point.
    3. Color — pigment cells; absorbed when hair turns gray.
    4. Follicle — depression or bag in which hair grows; describe.
12. *Mucous Membrane.* 1. Location — lines alimentary tract and all ducts leading into it, and the entire respiratory tract.
    2. Layers — two, the epithelial and serous; describe each.
13. *Serous Membrane.* 1. Location — lines internal surfaces not exposed to air. Names?
    2. Layers — endothelium and fibrous membrane; describe each.
    3. Function — a covering; to prevent friction.

QUESTIONS

1. What is the difference between *secretion* and *excretion*?
2. What are the coverings of the body?
3. What are the *layers* and *appendages* of the skin?
4. What are the functions of the skin? What glands are in the skin?
5. Describe the hair, giving layers, oil, and follicle.
6. Compare mucous and serous membranes. Where are they?

CHAPTER XXXII

THE SECRETORY SYSTEM — KIDNEYS

1. General Description. — The kidneys are bean-shaped glands, about four inches long, two inches wide, and something like an inch and a half thick, and weighing from four to six ounces. They are situated in the upper part of the abdominal cavity, just behind the intestines, and on either side of the spinal column. They are supplied with arteries, veins, and nerves; there is also a system of small tubes which run through the entire kidney and then unite in a kind of pocket or reservoir. Each has a tube about the size of a large goose quill, which carries the waste from the kidney to the bladder. The amount of fluid excreted by the kidneys per day is about three pints.

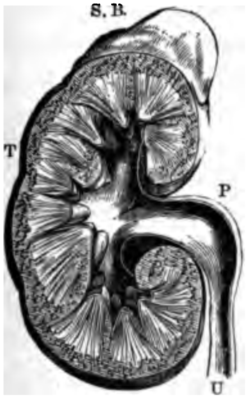


FIG. 48. — Section of a kidney.

P, pelvis; *T*, secreting part; *SB*, supra-renal body; *U*, ureter.

2. Use. — The function of the kidneys is to extract from the blood only waste materials, some water, some urea and salts, and to cast them out of the system. Their chief work is to remove urea, a poisonous waste material.

3. Kidneys and the Skin. — The skin and kidneys aid each other; either one can remove nearly all the waste of both, if it is necessary. A kidney can be removed by a surgeon, and the patient live and have good health. The skin will then do the work formerly done by the kidney.

If the skin becomes disabled, the kidneys aid it by removing more water. If the sweat glands are active, very little water is excreted by the kidneys.

4. **Excretion of Drugs.** — Most drugs are excreted by the kidneys; it is important, therefore, when drugs are being taken, to keep the kidneys active. There are many medicines that make the kidneys active, but one of the best things for this is an abundance of pure water. The liver seizes and excretes many poisons by means of its wonderful portal circulation; but whatever the liver does not get is taken up by the kidneys and passed out. Such drugs as carbolic acid, alcohol, and turpentine are excreted by the kidneys.

5. **Alcohol and Kidneys.** — Uric acid is a dangerous poison due to unoxidized foods. Alcohol, by preventing the oxidation of foods, and disturbing the function of the liver, is a cause of uric acid. The kidneys must remove uric acid, and any considerable amount of it overtaxes and breaks them down; frequently severe kidney diseases follow. It is claimed that fully one half of all kidney troubles are caused, directly or indirectly, by alcohol. It is known that alcohol is a leading cause of Bright's disease, the breaking down of the kidneys, and catarrh of the bladder. Excessive eating of pies, candies, cake, preserves, and sugar aids in making uric acid, which always overburdens the kidneys.

6. **Tobacco and Kidneys.** — The lungs remove a part of the nicotine in the breath, the skin does a share of it, but the kidneys have to excrete most of it. This extra work imposed upon the kidneys weakens them. Nicotine is the cause of some of the injury that results in Bright's disease. As the kidneys are the chief organs for removing

poisonous drugs, nicotine, even in small amounts, adds to their distress.

7. Diseases. — All kidney diseases can be traced to weakness caused by overwork, germs which the kidneys can throw off when they have normal strength, or to poisons which the kidneys should never be called upon to remove. Simple kidney disease usually shows itself in the form of an ugly bilious attack first, with the train of troubles that accompany biliousness. The leading kidney diseases are those in which there is sugar, albumin, blood, or pus in the urine, and that fatal organic disease known as Bright's disease.

8. Excretions by other Organs. — The liver, in its excretory function, overcomes or modifies many poisons which reach it through the portal circulation. It excretes bile which contains impurities taken from the blood. In certain states of disease, both the mucous and serous membrane excrete a sort of mucus, as in a cold. The intestines, along with their absorption, excrete waste materials which pass with the waste of the food.

9. Perspiration. — Just how important is the excretory function of the skin may be seen in the fact that if the skin were painted with something that would prevent its excretion, death would follow in a few minutes. The kidneys and the lungs would be unable to carry off all the waste matter and poisons. It is the evaporation of sweat that cools the body; when the air is dry, or in motion, or both, evaporation is rapid; when the air is heavy with water, and there is no breeze, evaporation is very slow, and the body becomes very warm. Then the water which should pass as sweat is thrown upon the kidneys. The skin should remove more water than the kidneys, but the total amount varies with temperature, exercise, mental

states, food, the fluids taken into the body, diseased conditions, and medicines taken. There are medicines that increase the flow of sweat.

10. Absorption. — Water, medicines, liquid food, and many poisons can be absorbed by the skin and carried into the general circulation. In this way food and water enough to satisfy the body for a time can be taken. If the epidermis is removed, the true skin will absorb much faster. Internally, food is absorbed by the mucous membrane and carried to the blood. By absorption of its own fat, the body may be sustained for some time; surgeons depend upon absorption to remove dead material after operations. Abnormal growths like tumors and cancers will be absorbed when their life is destroyed. The skin will absorb its own waste materials if they are left on the surface. Every unnecessary and harmful thing absorbed gives the kidneys extra work.

11. Waste and the Kidneys. — Repair and waste are a life process; the general work of secretion and excretion is the agent of this process. One set of glands prepares food for assimilation, while another set of glands separates from the blood all worn-out materials and poisons. In life's great work, the kidneys play an important part, as waste pipes are quite as important as any other.

The bladder, into which the kidneys empty, has also a very important function. The bladder is a membranous bag, very strong, very sensitive, easily injured, and difficult to cure. For good health, it is quite as necessary to train and protect this organ as any other.

OUTLINE SUMMARY

1. *General Description.* 1. Size — kidneys are bean-shaped. Dimensions.
   2. Location — in abdominal cavity, upper part, and on either side of spinal column.

3. Structure — system of tubes, arteries, veins, and nerves, and a drain tube called the ureter.

2. *Use.* 1. Secretion — water, urea, salts, and poisons.
   2. Excretion — urea, poisons, and other waste material.

3. *Kidneys and the Skin.* 1. Work — aid each other; each can do much work for the other.
   2. Surplus — each to some extent removes surplus of other.

4. *Excretion of Drugs.* 1. Special work — kidneys remove most drugs.
   2. Diuretics — many medicines make kidneys act; pure water.

5. *Alcohol and Kidneys.* 1. Uric acid — alcohol is a cause of uric acid, which the kidneys must remove.
   2. Kidney disorders — alcohol may cause Bright's disease, degeneration of kidneys, and catarrh of the bladder.

6. *Tobacco and Kidneys.* 1. Nicotine — kidneys have to remove most of it.
   2. Extra work — nicotine distresses the kidneys with extra work, and frequently causes disease.

7. *Diseases.* 1. Causes — overwork, germs, poisons; functional irregularities.
   2. Cure — most are curable. Make statement.

8. *Excretions by other Organs.* 1. Liver — excretes some poisons and some waste matter.
   2. Intestines — excrete waste material.
   3. Skin — water, poisons, some urea, and other waste materials.

9. *Perspiration.* 1. Painting the skin — would cause death in a few minutes.
   2. Amount — skin should remove greater part of waste water.

10. *Absorption.* 1. Use — takes up many useful and poisonous things. Make list.
    2. Effect on kidneys — gives them much extra work.

11. *Waste and the Kidneys.* 1. Repair and waste — life processes.
    2. Removal of waste — kidneys and their tubes are waste pipes.
    3. The bladder — a reservoir of waste; very sensitive.

QUESTIONS

1. What are the location, size, and structure of the kidneys?
2. What is the function of the kidneys?
3. What is the relation of the kidneys and the skin?
4. What is the effect of alcohol and tobacco upon the kidneys?
5. How are the kidneys affected by the work of other excretory organs?
6. What are *diuretics?*
7. What is the bladder? Its work?

CHAPTER XXXIII

HYGIENE OF THE SECRETORY SYSTEM — BATHING

1. A Clean Body. — Any odor from the body indicates waste material from the excretory organs, or dirt and filth, and should be removed by bathing. The frequency, time, and kind of bath depend upon many conditions. In a general way, every one should have a good bath of the whole body at least twice a week. In summer, in certain occupations, and in some diseases, it may be necessary to bathe daily. Any soluble material left on the surface may be absorbed, and act as a poison. Oil from the glands of the skin, dust, and other foreign bodies accumulate, stop further excretion, and breed germs of disease. All skin diseases are made worse by unclean skin. The other extreme of this is, after bathing the skin in warm water and soap, to rub so briskly as to roll up little heaps of epidermis, leaving the skin sensitive; it is possible to overdo as good a thing as bathing. After the skin is cleansed, it should be sponged off with cold water to put the capillaries and nerves in good condition. Warm water has the effect of drawing the blood to the capillaries, soothing the nerves, and relaxing the muscles. The natural effect is for the blood to flow back to the centers, and in the relaxed condition of the skin, it is easy to take a cold. The effect of a cold bath is first to drive the blood to the centers; in the reaction the blood comes bounding back to the capillaries.

2. Bathing. — Bathing produces (1) cleanliness, (2) a thermal effect, and (3) a tonic effect. To cleanse the skin, warm water, good soap, and a rough towel should

be used; warm water more readily dissolves soap, soap dissolves the oily material on the skin, and a good rough towel, aided by a little flushing with clean water, removes all the waste matter, leaving the skin clean and healthy.

3. **How to Bathe.** — A bath tub should be in every dwelling house. It is not a luxury, but a necessity. Hot water can be had by use of a small oil stove. In bathing, to get the best results, there should be sufficient water to immerse the body. But if this cannot be had, a good bath can be had by washing a part of the body at a time; for this purpose a good basin of water, a sponge or soft towel, a bar of soap, and a rough towel are sufficient. In completing a bath, one should rub skin briskly to arouse the activity of blood vessels, and put skin in good order; also, dry the skin thoroughly, especially when the weather is cold or damp, to prevent the chill that naturally follows.

4. **Cold Baths.** — A cold bath is an excellent tonic for those who can stand it. Most people in even fair health can become accustomed to it. This bath is taken, not for cleanliness, but for thermal effect. The first effect is to slightly shock the nerves, contract the blood vessels, and send the blood to the interior; the reaction, or second effect quickly follows, in which the blood comes back to the capillaries in increased quantity, the vessels dilate, and a feeling of warmth sets up all over the body. This is attended by an increased vigor, which is the real thermal effect. The cold bath is attended by some dangers; the shock to the nerves is sometimes too great for children, delicate persons, and the aged, and the reaction difficult to get. It must be done with judgment; quick work should follow, to bring about the reaction. Brisk rubbing, perfect drying of the skin, and dressing

with fresh, warm clothes will in nearly all cases produce the reaction. If the cold bath is too long, a chill and great weakness may follow. This should by all means be avoided. A good cold bath may be had by saturating a towel in cold water, applying it to the body, then rubbing briskly until body is dry. The cold bath should be taken as early in the day as possible; its tonic effect usually lasts throughout the day. If taken regularly every day, one can scarcely take cold, not even in drafts. It may be followed by vigorous work.

5. **Hot Baths.** — In a hot bath the skin is stimulated, the blood vessels are dilated, and the blood flows to the surface. The reaction comes when the blood is restored to the internal organs, and may not take place for several hours. A feeling of weakness and drowsiness follows the loss of blood by the internal organs. After hard mental labor, excitement, or grief, a hot bath will usually produce sleep by drawing blood away from the brain. When taken at night, it may break up a cold, provided one is kept warm throughout the night, and protected the next day. The hot bath should be taken in a warm room, and the body made perfectly dry before leaving the bathroom, as evaporation of any water left on the body produces a chill; great weakness and a cold may follow. The body should be kept warm for several hours. It is best to take the hot bath at night, and always follow it with a good rest.

6. **Turkish Baths.** — The Turkish bath is a double bath, first a hot bath and brisk rubbing until a good sweat is raised, then a copious cold bath and rubbing of the body until it is dry. The blood is first brought to the surface, then driven back to the internal organs, then brought to the surface again by the reaction from the cold bath. It

is best when taken at night. It is a refreshing bath, but there is danger of taking cold.

7. Sea Bathing. — Sea bathing is very refreshing, because of the movement of the waves, the salt in the water, and the sea breezes. Running water, like moving air, carries away the heat of the body rapidly, while salt is a great sustainer of life. About the same effect can be had by constructing a bath tub so as to have running salt water while bathing.

8. Bathing in Fevers. — Cold bathing is excellent to reduce fever, if skillfully done. It stimulates circulation and causes evaporation, which cools the sufferer. It also relieves the kidneys. But unless great care is exercised, the patient will take cold. A good way is to bathe part of the patient's body with a cold, wet cloth and rub until dry, then treat other parts in the same manner.

9. Too Much Bathing. — Bathing may be overdone; there are dangers, too, from remaining in the bath too long. Too much bathing lessens the epidermis, leaving the skin sensitive. Too much cold bathing will overstimulate the skin, and may be followed by some eruptions, like boils. Bathing, whether for cleanliness, thermal effect, or tonic effect, should be done quickly; one should always thoroughly dry the skin, and have due regard for the time of day, season of year, state of health, age, and work to follow.

OUTLINE SUMMARY

1. *A Clean Body.* 1. Odor — indicates waste material.
   2. Bathing — depends upon many conditions.
2. *Bathing.* 1. Purposes — three: cleanliness, thermal effect, and tonic effect.
   2. General effects hot and cold water. Make statement.
3. *How to Bathe.* 1. A bath tub — a necessity; it may be simple.
   2. Immerse body — if possible; if not, bathe by parts.
   3. Rubbing — almost as essential as washing; make skin dry.

4. *Cold Bath.* 1. Purpose — thermal and tonic effect.
   2. First effect — nervous shock, contraction of blood vessels, and sending blood to interior.
   3. Second effect — reaction. State effects.
   4. Dangers — shock too great, and reaction hard to get.
   5. Time — as early as possible in the day.
5. *Hot Baths.* 1. Purpose — thermal effect; to relax, and produce sleep.
   2. First effect — dilates capillaries and draws blood from internal organs.
   3. Reaction — blood restored to internal organs, after a time.
   4. Time — best at night.
   5. Dangers — taking cold.
6. *Turkish Bath.* 1. Form — a double bath, first hot, then cold.
   2. Effect — very invigorating, but some danger of cold.
7. *Sea Bathing.* 1. Effect — very refreshing because of flowing water, salt water, and sea breezes.
   2. Substitute — a tub provided with running salt water.
8. *Bathing in Fevers.* 1. Effect — cold bath reduces fever.
   2. Form — immersion, wrapping in cold, wet sheet, or by parts.
9. *Too Much Bathing.* 1. Habit — easy to overdo bathing.
   2. Effects numerous. Make statement.

CHAPTER XXXIV

HYGIENE OF THE SECRETORY SYSTEM (*continued*)

1. Washing Clothes. — Much of the epidermis rubs off and lodges in the clothing worn; also much waste material from the skin is taken up by the clothing. Clothes should be regularly washed and well aired. The bushman may seldom bathe his body or wash his clothes, but he is in the open air and sunshine nearly all the time; these two agents do much to cleanse the skin and clothing. But people who live indoors cannot rely on air and sunshine alone; the bushman would be better off if he did not. Most waste matter coming from the body is poisonous, and frequently contains disease germs. Some diseases may be caught by using the wash basin, soap, sheets, towels, pillows, and hair brushes that have been used by

persons having diseases; for this reason hotels, tenement houses, and boarding houses are breeding places of disease unless they are kept disinfected.

2. **A Beautiful Complexion.** — Nature alone can make a fair skin. Cosmetics are merely dirt; they clog the skin, destroy its natural vigor, and prevent its work. Many face powders and paints contain poisonous substances which are absorbed. If the liver, kidneys, stomach, and bowels are not doing their work, the blood is carrying extra poisons and other waste materials which will destroy the natural beauty of the skin. The only way to have a good complexion is by forming good habits of living, as good eating, good digestion, good assimilation, and good excretion. One should not overload the skin with the poisons of disease, and the bad odors and colors of a disordered digestion, disordered kidneys, and the reabsorbed poisons of bad excretions. Good health, good soap, soft, warm water, fresh air, and sunshine will make a complexion that no beauty artist can make.

3. **Chafing and Chapping.** — Chafing is caused by rubbing of moist surfaces. Fat people are usually very much troubled with it. Linseed oil, vaseline, or lanoline are good remedies; cold water is good for the parts when not too much irritated, as it soothes and toughens the skin. Chapping is caused by exposure of skin to cold winds. The epidermis thickens, and the skin hardens and cracks; sometimes the cracks are deep and an infection sets in, making a dangerous sore. It is very disagreeable in any form. The parts must be protected against the wind, and some healing salve applied. Linseed oil and paraffin mixed make a good remedy.

4. **Care of Nails.** — Nails should be carefully cleansed with nail brush, warm water, and soap. The edges

should be closely clipped, and no dirt allowed to gather under them; the surface should never be scraped or filed; the natural gloss should be preserved, and the fold of epidermis at the base should be gently retracted and the adhesion broken as fast as it forms, without breaking or cracking the fold. Nails should not be bitten, as the moisture of the lips injures the epidermis around them. Hangnails should be cut off close to the skin with a sharp knife or shears. Proper treatment will prevent them. Flesh scratched by the nails is never poisoned by the nails, but it is frequently poisoned by the filth under the nails. Ingrowing nails can be prevented by treatment, and by removing the pressure that made them.

5. **Care of Hair.** — The hair follicle has an oil which is sufficient to make the hair healthy, and give it a gloss. No hair oils should be used, and no hair dyes. The scalp should be kept clean by bathing with warm water and soap, and brushing with a bristle brush. No metallic brush should be used.

6. **Handling of Poisons.** — Poisons are very easily absorbed by the skin. Drug clerks, painters, and surgeons have to be very careful to avoid absorbing poisons. Poisons should never be handled with the naked hands, and when handled at all, some good antidotes should always be at hand.

7. **Alcohol and Excretion.** — The effect of alcohol on all excretions has been stated already, but it is proper to summarize it here. Alcohol interferes with the work of the stomach, liver, and intestines; their work being imperfect, extra poison from undigested food and extra waste from oxidation are thrown upon the excretory organs. At the same time, alcohol increases the force and frequency of the heart's action; it dilates the blood vessels

of the skin and lungs, and affects the air chambers of the lungs. Alcohol increases the load of all excretory organs, and decreases their power to carry the load; it affects nearly every gland in the body. Alcohol deprives the skin and tissues near it of nourishment; it permanently injures the vessels and nerves of the skin, overworks the sweat glands, and causes loss of heat. It overworks the kidneys, which finally break down, and some organic trouble like Bright's disease follows. It not only disables each excretory organ for its own work, but renders it unable to help the others.

8. Corns. — Corns are thickened, hardened epidermis, caused by pressure. In the hand, they may be caused by tools; in the foot, they are caused by the pressure of tight shoes, or the rubbing of loose shoes. They are made by changing the number, shape, and density of the cells. As the old cells are removed, new ones take the shape of the old ones; this makes it difficult to cure corns. The pressure should be removed and the corn either cut off, dissolved, or burned out.

OUTLINE SUMMARY

1. *Washing Clothes.* 1. Necessity — all clothing worn next to skin, and bed linens.
   2. Aids — plenty of fresh air and sunshine.
2. *A Beautiful Complexion.* 1. Natural — nature alone can make it.
   2. Cosmetics — they are so much dirt; sometimes poisonous.
   3. How to make it — good habits; correct eating, good digestion, good assimilation, and regular excretions.
3. *Chafing and Chapping.* 1. Chafing — caused by friction of moist surfaces. Remedies.
   2. Chapping — caused by exposure to rough winds. Remedies.
4. *Care of Nails.* 1. Cleaning — clean with nail brush, warm water, and soap.
   2. Cutting. Make statement.
   3. Hangnails — prevent; clip with sharp knife; do not tear them.
   4. Ingrowing nails — cut off, and remove pressure.

5. *Care of Hair.* 1. Oil — use no oil or dye on the hair.
   2. Clean scalp — with warm water, soap, and a good brush.

6. *Handling of Poisons.* 1. Absorption — poisons are quickly absorbed.
   2. Protection — protect naked hands; have a good antidote.

7. *Alcohol and Excretion.* 1. Effect — on excretions. Make statement.
   2. Indirect influence — through circulation, digestion, and the nerves.

8. *Corns.* 1. Cause — pressure.
   2. Cure — remove cause, and cut, dissolve, or burn out.

QUESTIONS

1. Why is bathing the body necessary? How often?
2. What are the purposes of bathing?
3. How should one bathe?
4. What are the effects of a cold bath? A hot bath?
5. What is a Turkish bath?
6. What is the effect of sea bathing?
7. How make a beautiful complexion?
8. How treat chafing and chapping?
9. What is the effect of alcohol and tobacco on the excretions?
10. What is the cause of corns?

CHAPTER XXXV

THE NERVOUS SYSTEM — THE BRAIN

1. Function of the Nervous System. — As already stated, the three ends of physiological action are motion, nourishment, and control. The systems that produce motion and nourishment have been described. The last great end, namely, control, is secured through the operation of the nervous system. The function of the nervous system is *control;* no physiological action is possible except through the nerves. All other systems get their powers from the nerves.

All nerve tissue is composed of what is known as gray

FIG. 49. — The nervous system.

nerve matter, or white nerve matter, or both. The gray matter is composed of very small sacs filled with fluid, and the white is composed of fibers.

2. Divisions of Nervous System. — The entire nervous system is a great unit, but for convenience it is divided into (1) the *central nervous system*, and (2) the *sympathetic system*. The central nervous system is composed of the brain, spinal cord, and all their nerve branches; there are twelve pairs of cranial nerves, and thirty-one pairs of spinal nerves, eight *cervical*, twelve *dorsal*, five *lumbar*, five *sacral*, and one from the *coccyx*. The sympathetic system is composed of two chains of *ganglia*, or little knots of nerve matter, their branching nerves, and plexuses.

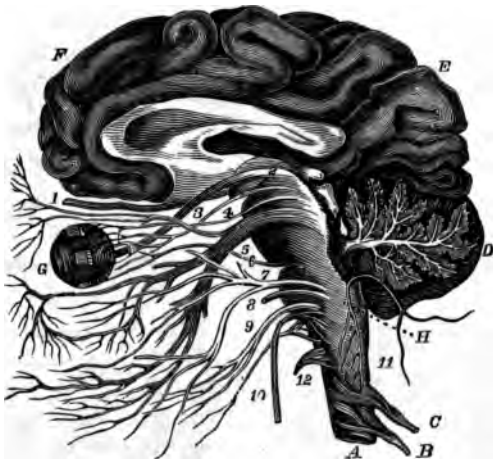


FIG. 50. — The brain and the origin of the twelve pairs of cranial nerves.

F, *E*, the cerebrum; *D*, the cerebellum, showing the arbor vitæ; *G*, the eye; *H*, the medulla oblongata; *A*, the spinal cord; *C* and *B*, the first two pairs of spinal nerves.

3. The Brain. — The brain occupies the cavity of the cranium, and is the largest mass of nerve matter in the body. The brain of the male has an average weight of nearly 50 ounces, and the brain of the female averages about 44 ounces. The average size is about 90 cubic inches. Daniel Webster's brain was 122 cubic inches in

size, and weighed nearly 54 ounces, while the brain of a great French naturalist, Cuvier, weighed 64 ounces. The brain of an idiot is usually small and light, many of them weighing less than 20 ounces. The higher in the scale of intelligence the larger the brain is, generally ; but there are some exceptions to this. Size is an important item, but other qualities are equally valuable.

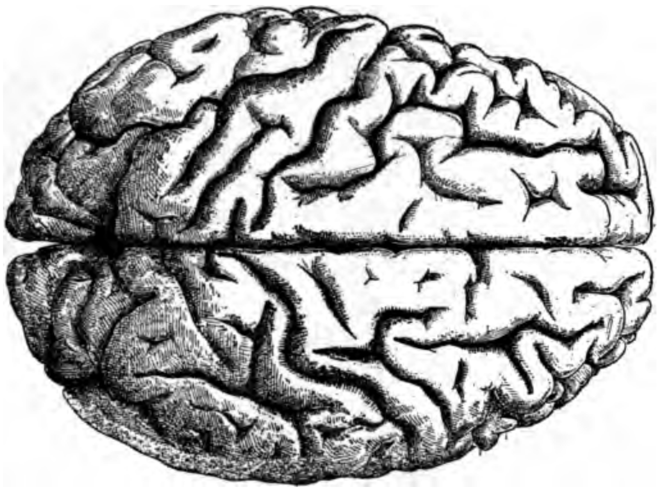


Fig. 51. — View of the brain as seen from above.

Only the cerebrum appears, since it covers the other parts. The halves are the hemispheres and the ridges are the convolutions. The front part of the brain is at the right in the figure. (Van Gehuchten.)

The brain is composed of the *cerebrum*, *cerebellum*, *pons Varolii*, and the *medulla oblongata*. It has three membranes or coverings, two larger openings called the lateral sinuses, and three small openings called the third, fourth, and fifth ventricles. The brain is almost cut into two parts by a deep fissure running from the front to the back ; the parts are called the left and right brain, or the left and right hemispheres. The hemispheres are bound together

by a mass of white material called the *corpus calossum*, stronger and more dense than the white matter of the brain. The bulk of the brain is white matter, which is covered with a layer of gray matter about one fourth of an inch in thickness.

4. **Membranes.** — The covering of the brain is composed of three layers, or membranes: (1) the *dura mater*, (2) the *arachnoid*, and (3) the *pia mater*. The dura mater, or outer covering, is a firm, strong, serous membrane, adhering to the inner surface of the cranium, taking the place of the periosteum; it dips down into the fissures of the brain, and covers the nerves as they pass through the walls of the cranium. The arachnoid, or middle covering, is a very delicate serous membrane; it does not fit closely either the outer or inner covering of the brain, the space on both sides being occupied

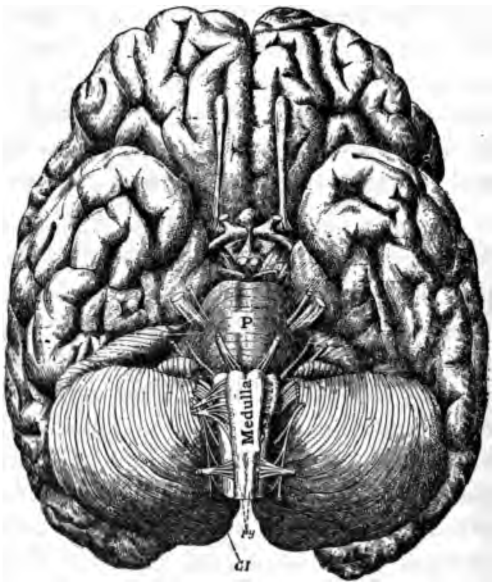


FIG. 52. — View of the under side of the brain.

The part showing the convolutions is the cerebrum. The parts in the lower part of the figure showing the curved parallel lines are the two halves of the cerebellum. *CI* points to the first pair of spinal nerves. This pair is attached to the beginning of the spinal cord. Above this pair are the twelve pairs of cranial nerves. The part above the roots of this pair (*CI*) as far as the sixth pair is the medulla. *P* is on the pons. (Van Gehuchten.)

by a serous fluid; it has the appearance of a very delicate veil. The pia mater, or inner covering, is a soft structure of blood vessels and fibrous tissues; it adheres closely to the brain surface, following the ridges and fissures. The pia mater protects the brain, carries nourishment, and removes some waste. The arachnoid, with its serous fluid, prevents friction and breaks the force of shock. The dura mater furnishes the chief protection from fractures of the cranium and external violence. The arrangement is a wise one, affording perfect nourishment and protection.

5. Divisions of the Brain. — The divisions of the brain are sharply marked off from each other. Each is divided into two very similar hemispheres by a fissure from front to back, the hemispheres being bound in the center by a mass of white matter. The divisions differ in size, shape, and function, but their general structure is similar.

6. The Cerebrum.—The cerebrum is about seven eighths of the entire brain substance, and occupies all of the upper part of the cranial cavity. There is a deep fissure running from front to back, cutting both the frontal and occipital regions entirely in two. The two halves, or hemispheres, as they are called, are almost alike, except that one is right and the other left, as much alike as the eyes or hands. The outer sides of the hemispheres have two deep fissures in the region of the ear. The surface of the cerebrum is marked with depressions called *furrows*, some of them about an inch deep. The ridges between them are called *convolutions*. This arrangement increases the brain surface, and affords space for more gray matter. The gray matter is the seat of nerve power, and perhaps intelligence. As we descend the scale of intelligence, the convolutions are not so high, and gray matter not so highly organized; in many idiots they are wanting almost alto-

gether, while the more stupid lower animals seem to be without them.

Each hemisphere is divided into five lobes by fissures; the base of the cerebrum is still further divided into smaller parts, or regions, each seeming to have a pretty well defined work to do. The cerebrum as a whole has the following regions: in the upper and central portion the *parietal* region, about the ear the *temporal* region, and in the back of the head the *occipital* region.

7. **The Cerebellum.** — The cerebellum, or little brain, is situated in the base and back part of the cranium, under the rear end of the cerebrum, and just over the medulla oblongata. It is only about one eighth as large as the cerebrum, and is somewhat oblong in shape. The cerebellum does not have convolutions; but shallow furrows run in irregular curves. The cerebellum is a mass of white nerve fibers, covered with a coat of gray matter only about $\frac{1}{15}$ of an inch thick. The white nerve fibers, or cells, connect the gray cells and other parts of the nervous system. The cerebellum has a peculiar arrangement of its exterior layers by which the white matter runs out in very fine branches like the twigs of a tree. The arrangement is called *arbor vitæ*.

8. **Pons Varolii.** — The pons Varolii, as its name indicates, is a sort of bridge, binding together the other portions of the brain; it is sometimes called the middle brain, and is situated somewhat between the hemisphere of the cerebellum and above the medulla oblongata, connecting that division with both the cerebrum and cerebellum. It is composed of white nerve fibers that alternate, while gray matter is intermixed.

9. **Medulla Oblongata.** — The medulla oblongata is really an extension of the spinal cord; it connects the pons

and the cord, is about an inch and a quarter long, three quarters of an inch wide, half an inch thick, and tapers toward the lower end. Its gray matter is in the center, covered with an exterior coat of white matter, like the cord.

OUTLINE SUMMARY

1. *Functions of the Nervous System.* 1. Control — the purpose of the nervous system is control.
   2. Nerve tissue — gray matter and white matter.
2. *Divisions of the Nervous System.* 1. Central nervous system — brain, spinal cord, and nerves.
   2. Sympathetic system — ganglia, branching nerves, and plexuses.
3. *The Brain.* 1. Size — average about 90 cubic inches, weighs from 45 to 50 ounces.
   2. Parts — four divisions and three coverings.
   3. Fissures — two principal ones, and many minor ones.
   4. Corpus calossum — binds the two hemispheres together.
   5. White and gray matter — gray matter about one fourth of an inch thick, covering the white matter.
   6. Sulci — depressions upon the brain surface.
   7. Convolutions — ridges between the sulci.
4. *Membranes.* 1. Number — three, the dura mater, arachnoid, and pia mater.
   2. Uses — protect and nourish the brain.
5. *Divisions.* 1. Number — four.
   2. Names — cerebrum, cerebellum, pons varolii, and medulla.
6. *The Cerebrum.* 1. Comparative size — about seven eighths of entire brain.
   2. Lateral fissures — two, in region of ear.
   3. Convolutions — numerous; increase surface for gray matter.
   4. Intelligence — seems to have a relation to size and organization of convolution.
   5. Lobes — five lobes in each hemisphere.
   6. Regions. Make statement — localization.
   7. Use. Make statement.
7. *Cerebellum.* 1. Location — base and back part of cerebrum, over medulla.
   2. Size — only about one eighth size of cerebrum.
   3. Furrows — shallow, and in irregular curves; no convolutions.
   4. Structure — a mass of white nerve fibers covered with thin layers of gray.
   5. Use — connects gray cells and other parts of brain.
8. *Pons Varolii.* 1. Location — somewhat between the hemispheres of the cerebellum, above the medulla.
   2. Use — a sort of bridge, binding the other parts of the brain.

3. Structure — composed of layers of white nerve fibers that alternate, while gray matter is intermixed.

9. *Medulla Oblongata.* 1. Size — about an inch and a quarter long and three quarters of an inch wide.
2. Structure — gray matter in center like the cord.

CHAPTER XXXVI

SPINAL CORD, NERVES, AND SYMPATHETIC SYSTEM

1. **The Spinal Cord.** — The spinal canal is occupied by the spinal cord, which is a continuation of the brain; the cord is about sixteen or eighteen inches long, and about half an inch in diameter. It extends from the opening of the occipital bone to the lower edge of the first lumbar vertebra, a point about opposite the lowest rib. The cord is in the shape of a cylinder. The coverings of the cord are an extension of the covering of the brain. The dura of the cord does not serve as a periosteum, like that of the cranium; it has no channels for blood vessels, and does not dip into the fissures of the cord; it is attached to the bones of the spine by small fibers. The

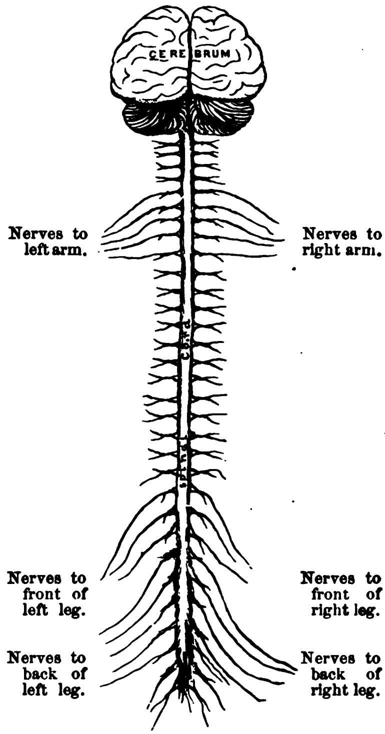


FIG. 53. — Brain and spinal cord, with the thirty-one pairs of spinal nerves.

cord has two fissures, one before and the other behind, dividing it into two equal parts; each part is divided by a depression along its side into two parts, called the anterior and posterior columns. The gray matter of the cord is on the inside, and the white matter on the outside; a pair of nerves go out from the cord at each vertebra.

2. **Gray Matter.** — The gray matter of the nerve tissue is composed of cells of various shapes, but generally sphere-like. The gray matter is soft, and is easily destroyed by pressure or violence. In color it is an ashy gray, with a slight tint of red, slightly darker in the dark races. Gray matter is on the outside of the brain, the inside of the spinal cord, and in ganglia. The whole mass of gray matter is bound together by very delicate fibers of connective tissue.

FIG. 54. — Nerve cells. (Magnified.)

3. **White Matter.** — White nerve matter is fibrous; it is made up of small fibers, which, with the framework that unites them, constitute the mass of all nerves. It composes the central part or body of the brain, the outer part of the spinal cord, and a large part of all ganglia. All nerves are composed of white matter.

4. **Nerves.** — Most nerve fibers have three parts: (1) a sheath or covering (*neurilemma*); (2) *white substance of Schwann*, the soft white matter within the sheath; and (3) the *axis cylinder*, a gray thread running through the center of the nerve. A complete nerve, as it is seen in the body, is composed of bundles of fibers, united by a delicate framework, and contained within a sheath (*perineurium*),

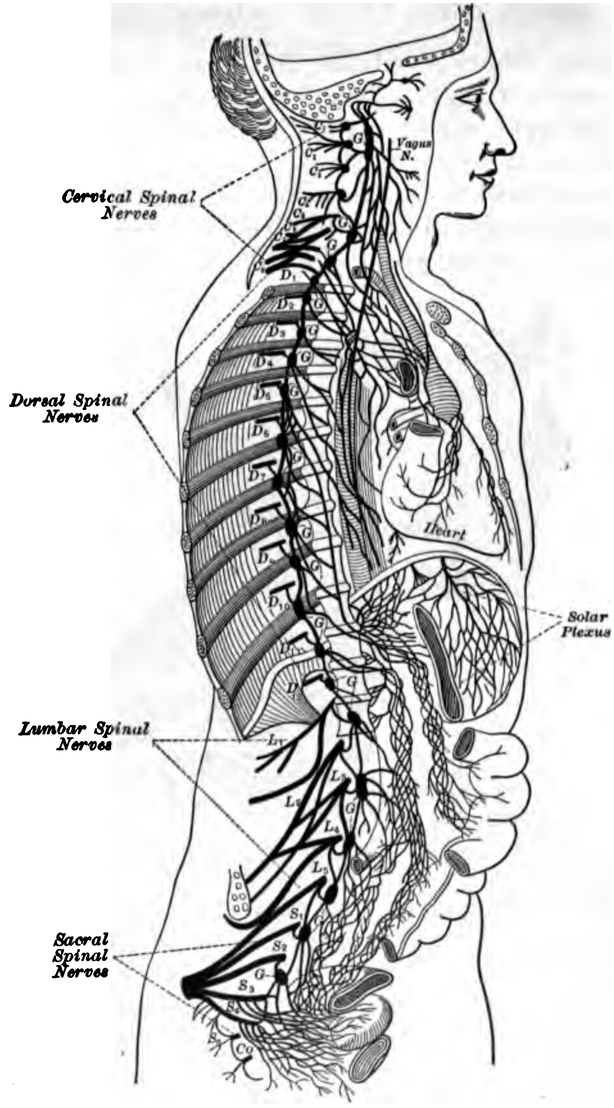


Fig. 55.—Diagram of the sympathetic nervous system.

G, ganglion chain; *Co*, coccygeal spinal nerve.

a strong, fibrous membrane that protects the fibers and gives them strength. Bound up in a nerve sheath there may be found, usually, several nerve fibers, some with one function and some with another.

The little white threads called nerves are extensions of the larger nerve organs; they go to every tissue and act upon every vessel, gland, and cell in the body, excepting

Fig. 56. — Nerves of the face and neck.

the cells of the epidermis and of its modified forms. They are divided into two general classes: (1) nerves of the *central system;* and (2) nerves of the *sympathetic system;* the former are divided into (1) the *cranial* and (2) the *spinal* nerves.

5. Cranial Nerves. — Cranial nerves originate in the brain. Several cranial nerves have a common origin, even at first occupying the same sheath, but separating to go to

different places, and for different functions. There are twelve pairs, known usually by their numbers. The following is a list of the cranial nerves by number, name, place, and function:

1. Olfactory, to nose; nerve of smell.
2. Optic, to eyeballs; nerve of sight.
3. Motor oculi, to eyeball; nerve of motion.
4. Pathetic, to muscles of eyeball; nerve of motion.
5. Trifacial, to tongue, eye, upper and lower jaw, and face; nerve of taste, sensation, and motion.
6. Abducens, to muscle of eye; nerve of motion.
7. Facial, to side of face; nerve of expression.
8. Auditory, to internal ear; nerve of hearing.
9. Glosso-pharyngeal, to tongue and pharynx; nerve of taste, motion, and sensation.
10. Pneumogastric, to lungs, heart, and stomach; nerve of sensation and motion.
11. Spinal accessory, to muscles of the neck; nerve of sensation and motion.
12. Hypoglossal, to tongue; nerve of motion.

6. Spinal Nerves. — The spinal nerves are in pairs, thirty-one in number. There are eight pairs of cervical nerves that go to the neck and arms; twelve pairs of dorsal nerves that go to the trunk; five pairs of lumbar nerves, five pairs of sacral nerves, and one pair from the coccyx that go to the internal abdominal organs and to the lower limbs. All spinal nerves have two roots, one rising from the front column of the cord, and the other from the rear column. The front root of a spinal nerve is the root of motion, and the rear one is the

FIG. 57. — Section of spinal cord, with nerves. *a*, ganglion in root; *s*, sensory root; *m*, motor root.

root of sensation. If a root be injured or cut, its function is lost; if the whole nerve is cut, both sensation and motion are lost. Each nerve of sensation, after leaving the cord, has a *ganglion*. Some of the spinal nerves unite in a sort of network called a *plexus*, and then separate and go on their way. There are several important plexuses; among them are (1) the *cervical*, formed by the upper four cervical nerves; (2) the *brachial*, near the armpit, formed by the lower four cervical and first dorsal nerves; (3) the *lumbar*, in the small of the back, formed by the upper four lumbar nerves; and (4) the *sacral*, on the inner surface of the sacrum, formed by the last lumbar and upper three sacral nerves.

7. **The Sympathetic System.** — The sympathetic system is composed of two chains of ganglia, nerves, and plexuses. The ganglia are little knots of nerve matter about the size of a grain of corn, and arranged in rows, one row on each side of the spinal column. The nerves of the sympathetic system are tiny fibers, much smaller than ordinary nerves, and seem to consist of a single fiber something like the axis cylinder of an ordinary nerve. They connect the cells of different ganglia with each other, with the cells of the spinal cord, with the brain, and with the organs that the sympathetic system seems to regulate. The spinal cord controls action, peristalsis, and the growth of cells, but it is done through the ganglia. Ganglia, through the nerves, indirectly control the action of the arteries, peristalsis of intestines, secretion of glands, and the growth of cells; ganglia are in chief control of the heart. The brain seldom exercises any direct control over ganglia, though in some cases it does. The work of ganglia is reflex, merely an aid to the central system. Any demand for cell action, nutrition, circulation, and digestion may go

to the ganglia only; if the demand is stronger, it may reach the cord, and be referred to ganglia for execution; and only when the impulse is very strong, it may reach the brain, and then be referred to the cord, or the ganglia.

8. **Ganglia.** — There are about thirty pairs of ganglia along the spinal column; there are four important ones also in the head. Some of the cranial nerves have ganglia. Ganglia are composed of both gray and white matter, both sensory and motor nerves, and preside over the work of the vital processes.

9. **Plexuses.** — The sympathetic system contains several plexuses: (1) the *solar plexus*, located just behind the stomach; (2) the *aortic plexus*, located upon the aorta, and sending branches into the chest and abdomen; and (3) the *cardiac plexus*, situated within the walls of the heart. The solar plexus is sometimes called the "abdominal brain." It is very sensitive; a blow upon the stomach may cause death from shock received by the nerves of the solar plexus and sent to the brain. Its branches go to the stomach and other upper abdominal organs. The aortic plexus supplies the aorta and its main branches. The cardiac plexus sends its tiny branches to the tissues of the heart and surrounding structures.

OUTLINE SUMMARY

1. *Spinal Cord.* 1. Location — spinal canal; from occipital bone to lower edge of first lumbar vertebra.
   2. Size — sixteen to eighteen inches long and about half an inch in diameter.
   3. Coverings — same as brain.
   4. Dura — is not a periosteum, has no channels for blood vessels.
   5. Fissures — two, anterior and posterior.
   6. Columns — right and left anterior, right and left posterior.
   7. Arrangement — gray matter interior, and white exterior.
   8. Nerves — a pair go out at each vertebra.

2. *Gray Matter.* 1. Cells — generally spherelike.
   2. Where found. Make statement.
3. *White Matter.* 1. Cells — fibrous.
   2. Where found. Make statement.
4. *Nerves.* 1. Composition — fibers of white nerve matter.
   2. Parts of nerves — three; name them.
   3. Classes — two, central and sympathetic; the central nerves are cranial and spinal.
5. *Cranial Nerves.* 1. Pairs — twelve.
   2. Names. Make statement.
6. *Spinal Nerves.* 1. Pairs — thirty-one.
   2. Divisions — cervical, dorsal, lumbar, sacral, and coccygeal.
   3. Distribution. Make statement.
   4. Roots — two, one motor, and the other sensory.
   5. Plexuses — cervical, brachial, lumbar, and sacral.
7. *Sympathetic System.* 1. Parts — two chains of ganglia, nerves, and plexuses.
   2. Function — control action of arteries, peristalsis, secretions, etc.
8. *Ganglia.* 1. Description — little knots of nerve matter.
   2. Pairs — about thirty along spinal column, and few in the head.
   3. Composition — both white and gray matter.
   4. Function — preside over several vital processes.
9. *Plexuses.* 1. Description — a kind of network of nerve matter.
   2. Important plexuses — solar, aortic, and cardiac.
   3. Function. Make statement.

CHAPTER XXXVII

WORK OF THE NERVOUS SYSTEM

1. Motor and Sensory Function. — When anything touches the cells of the body, they send a message or impulse to the brain, making known what has happened; if they are hungry, cold, or sick, they send a suitable impulse, and the mind takes notice of their wants, and answers. Sometimes an impulse is sent to a ganglion, or to the spinal cord instead of the brain, and the ganglion or cord will send back an impulse very much as the brain does it. The message sent to the brain, ganglion, or cord is called a *sensation*, and the one returned in answer is called the *motor impulse.* The nerves that carry the im-

pulse are called *sensory*, and the nerves that bring back the order are called *motor*. Motor impulses may originate in the mind, as when the will orders an act to be done.

The functions of the nervous system are (1) to originate nerve force with which to carry on motor and sensory action; (2) sending impulses in and out; and (3) receiving impressions from without. The first act is done by the gray matter of the nervous system, the second by the white matter, and the third act is done mainly by the end organs of the nerves, such as the eye, ear, and other nerve ends.

Sensations are of two kinds : (1) common, and (2) special. A common sensation seems to affect the whole body, like hunger, thirst, and fatigue; it seems to be located in a given place, as thirst in the mouth, but the whole body is affected. Special sensations are those requiring a special organ, such as touch, taste, sight, hearing, and smell; they are called the special senses. Motor impulses are of three kinds: (1) motion, (2) secretion, (3) growth.

2. Sensory Regions. — A sensory impression that reaches the mind is called a sensation. There are certain regions in the brain to receive the impulse from a given end organ. The whole brain cannot act upon every little sensation that comes to it. The sensations of sight are felt in the occipital region; the impulses from the ear, nose, and tongue go to the temporal region; and impulses of touch go to the parietal region. In case of lost feeling, the injury may be in the region that should receive impulses from the touch. If the region of sight is destroyed by disease or accident, sight impressions cannot get any response, and the patient is said to be blind. If an aching tooth be extracted, and the nerve left exposed, it will feel

as if the tooth were still aching; the brain region finally adapts itself to the condition, or the nerve shrinks.

3. Motor Regions. — The motor regions extend across the sides of the head almost from bottom to top, and in front of the ear. The special set of nerve cells that control a given muscle is called its *motor center*. Motor impulses are received by the white matter of the cerebrum, the medulla, and cord, and sent out along a motor nerve to some muscle, commanding the muscle to act. When the motor center of a given muscle is injured, paralysis of the muscle follows. Paralysis is frequently due also to mechanical pressure on the motor center, the medulla, spinal cord, or the motor nerve that supplies the muscle. Some bad cases of paralysis have been cured by finding and removing the pressure.

Motor and sensory regions are closely connected by fibers of white matter, and the action of each is suited to the action of the other; thus a person gauges the motor act of jumping according to the sensory impression of the distance to be jumped. This act is called *coördination*, or *accommodation*. Although the sense may be in error, the motor impulse will accommodate to it; when the sensation of distance is in error, the ground being nearer or farther than it seems, the step will make as much error as the eye made, and the act is sometimes very amusing.

4. A Central Governing Power. — No machine can operate without governing power; there must be authority properly lodged somewhere, and all parts of the machine must obey the authority and follow the rules. The human body is no exception to this law; every organ, when in a state of health, is in perfect obedience. When heat is needed, something orders oxidation to increase, until the supply equals demand. If there is too much heat, the pores open,

perspiration follows, and the surplus is given off. If the skin is unable to do all its work, the kidneys and lungs aid. When sugar is needed, the liver reconverts some of its glycogen, and liberates it. Everything in the body lends willing obedience in its own duties, and willing aid to other organs. But whence come the orders?

Each vital function is controlled by a nerve center; every motor act has its center. But what controls the centers? The answer is, that the mind, a thing higher than all nerve centers, controls them; when the mind is gone, only the simplest reflex acts are done, and they do not go on very long. Mind is not a function of nerve cells, but is a thing apart; it is intimately associated with the action of the nerve centers, but can approve or disapprove the proposed act of a nerve center, as it chooses. It is the highest form of what is known as life. Let us not confuse mind with the mere action of nerve centers.

5. Work of Cerebrum.—The mind manifests itself in three ways, known as (1) intellect, the acts of the mind, as thinking and judging; (2) feeling, the states of the mind, as love, hate, conscience; and (3) will, the making a choice or performing an act. It is believed that the cerebrum is the organ of the mind, but the exact relation between the two no one knows. We do know that the two are very closely related; if the brain become diseased, the mind will weaken; when the brain recovers, the mind usually clears up. It is also true that activity in mind makes the brain grow.

If the cerebrum is removed from a bird, it will lose its power to sing, sit about in a stupor, and move only when acted upon by some stimulus. The bird will live, but loses its brightness, and will no longer try to escape. If

one loses his mind, the cerebrum will begin to shrink and shrivel; if the brain is poorly nourished, the mind grows weaker.

6. **Work of Cerebellum.** — When the cerebellum becomes diseased, the power to carry on different muscular actions is impaired and sometimes lost. One can usually perform a single act, but no acts requiring rapid changes; his gait is unsteady, and he seems to have lost his balance, or coördination; but this is not always the case. If the cerebellum be removed from a pigeon, it will lose its gait, because the muscles do not act together; it cannot easily pick up food, because it seems to have lost its sense of distance. It seems that the cerebellum makes the muscles of one side of the body act with those of the other side.

7. **The Function of the Pons Varolii.** — The chief use of the pons seems to be to aid other portions of the brain in the work of coördinating muscular action and sending impulses by its white fibers. It serves as an important connection between other parts of the brain. When diseased, its effects are something like those of the cerebellum.

8. **The Work of the Medulla.** — The medulla is one of the most important organs of the brain. It seems to be the central switch board for the vital functions of the whole body. The nerve centers of the medulla control breathing, action of the heart, swallowing, peristalsis, and many other acts.

9. **Nerve Centers.** — A collection of cells and their fibers, which has a distinct work to do, is called a "nerve center." The essential feature is their gray matter, whether the "center" be a ganglion of a purely reflex act, or the *respiratory* center. Centers for specialized work are found

in nearly all parts of the system. The sight centers, hearing centers, mental centers, and ganglia are all examples. Such things as action of the kidneys, action of the bowels, and action of the liver are directed by definite centers. Gray matter originates nerve force, and white matter carries the impulse.

OUTLINE SUMMARY

1. *Motor and Sensory Function.* 1. The motor function — sending an impulse along a nerve for action only.
   2. The sensory function — sending an impulse along a nerve to a center.
   3. Origin of motor impulses — in the mind, or in a sensation. Make statement.
   4. Kinds of sensations — two, common and special.
   5. Kinds of motor impulses — three: motion, secretion, and growth.
2. *Sensory Regions.* 1. Location. Make statement.
   2. Disturbed or lost function. Make statement.
3. *Motor Regions.* 1. Location. Make statement.
   2. Motor centers — special set of nerve cells.
   3. Paralysis — injury to nerve or center, or mechanical pressure.
   4. Coördination — balancing motor and sensory impulses.
4. *A Central Governing Power.* 1. An example of obedience — the human body.
   2. The final authority — the mind.
5. *Work of Cerebrum.* 1. Manifestations of mind — intellect, feelings, and will.
   2. Organ of mind — cerebrum.
   3. The unseen relation — mind and brain.
6. *Work of Cerebellum.* 1. Experiments — on man and lower animals. Make statement.
   2. Coördination — it seems to be the function of the cerebellum.
7. *Function of Pons Varolii.* 1. A "bridge" — connects other parts of brain.
   2. An aid — its chief use, coördinating muscular action and in transmitting impulses.
8. *Work of the Medulla.* 1. A central "switch board" — seat of many "centers." Make statement.
   2. Distributing point — most important in the body.
9. *Nerve Centers.* 1. Definition — collection of cells and fibers with a specialized work.
   2. Specialized work — seen in any vital act of the body.

CHAPTER XXXVIII

WORK OF THE NERVOUS SYSTEM (*continued*)

1. Function of Spinal Cord. — The spinal cord is a sort of second brain; it is a great center of reflex action; in many cases the cord will act before the brain can adjust itself to the sensation. Most vital processes are forms of reflex action, and frequently their impulses do not reach the brain. Many other impulses never reach the brain, and are acted upon without the aid of the mind at all. Most of our physical acts when we are asleep belong to this class, as, when becoming chilly, we unconsciously draw the bed clothing about us, or when tired of lying upon one side, turn upon the other without waking. In this way the brain is relieved of much drudgery. The cord has a good supply of gray matter, which enables a center to perform an act on its own account. It has been claimed that the cord has a minor degree of intelligence, as shown by experiments upon lower animals; the brain was removed, and the cord performed intelligent acts. But these experiments do not give satisfactory proof; habit can account for all such acts.

2. Work of the Sympathetic System. — The work of the nerves of the sympathetic system, as already learned, is closely connected with all vital action. The nerves, sent out from ganglia and plexuses, reach all the organs of both the thorax and abdomen; they go to the lungs, heart, stomach, liver, bowels, kidneys, and skin, and influence the acts of all these organs. They are sometimes called the nerves of organic life. It is well known that when one organ is injured, the work of another organ may

be upset, as when the stomach is deranged, the heart may palpitate. Because one organ seems to share the distress of another through the action of these nerves, this system is called the "sympathetic system." In this system there are both sensory and motor nerves; but if cut off from the cord, they send but few impulses, from which it would seem that the sympathetic system not only aids the cord, but it gets most of its nerve force from the cord.

The nerves of the sympathetic system are not so easily influenced from without as other nerves, but they are rather easily influenced by poisons. Some poisons taken inwardly will almost destroy their action, and poisons developed within the body, as uric acid, greatly impair them.

3. Reflex Action. — Reflex action has been defined already, and an example or two will be sufficient to make this important act clear. A reflex act consists in receiving an impression by a nerve end organ, sending the impulse along a nerve to a nerve center (in ganglion, cord, or brain), the action of the center upon the impulse, and sending a new impulse from the center along another nerve to some organ or tissue to make an act. In a reflex act there are three organs and five movements. The three organs are (1) the end organ to receive the impression, (2) nerve fibers to carry the impulse, and (3) a nerve center to act upon the impulses. The five acts are (1) making the impression, (2) carrying the impulse to a center, (3) the act of the center in starting a new force, (4) carrying the new impulse to some new part, and (5) the resulting act. The impulse of sensation is carried along a sensory nerve fiber, and that of motion along a motor nerve fiber. Both fibers are sometimes in the same sheath, as is the case with all spinal nerves; but some

cranial nerves have only sensory fibers, others have only motor fibers, and others have both.

Examples of reflex action may be given at any length. The quick withdrawal of the hand when it has touched a hot stove; the rapid motion of a chicken's body when its head is cut off; or the quick closing of the eye when a mote gets into it, — all of these acts are done before the mind can act; they are examples of reflex action. Vomiting caused by a smell, blushing caused by teasing, or jumping when the door bell rings are good examples. A reflex act may be due to the simplest sensation, or it may be an act of life or death. In some cases, too, the impulse may be psychic, that is, coming from the mind to a center, and the rest of the act as above described; this is a *modified reflex act*. All such acts as secretion of saliva, beating of the heart, and peristaltic action are not pure reflex acts, as they are not due to external stimuli; they are modified by habit and other conditions, and are sometimes called *automatic reflex acts*.

4. Volitional Action. — A volitional act starts in the mind; it does not come directly from any external stimuli. Such acts involve a higher form of nerve action than reflex action. The mind acting in the form of will may stop a reflex act altogether, however strong the stimulus, as in the case of getting a mote in one's eye; by an effort of the will, the eye may be made to stand open, notwithstanding pain. This higher, or volitional, force governs to some extent nearly all forms of nerve action. By an effort of the will, one may accomplish almost any nerve act in the body, or resist to some extent even disease and death.

5. Sleep. — The cerebrum, which is the seat of the mind, cannot always work. When we are awake, the

active brain uses a large amount of food, and makes much waste. Repair cannot always go on so fast as waste, and the body becomes tired. Nature has provided a way called sleep, by which repair keeps up with waste. When we are asleep, repair goes on throughout the entire body. About one third of one's life must be spent in sleep; it should be regular and sound, and taken in the night. In early life, nearly half of a child's time should be spent in sleep; at ten years of age he needs about ten hours; at twenty and thereafter, not less than eight hours; in old age more sleep is required because repair is slower. The rest during sleep should not be broken.

6. **Habit.** — When any nervous act is repeated a few times, it becomes much easier to do; the cells adapt themselves to the repeated act. They are so changed in growth, and sometimes in shape, as to do the act almost without the aid of the will. This change is called habit. When cells are trained to do an act by themselves, we say that the act is *automatic*. If it were not for habit, no advancement could be made; we could not learn to walk, read, or write. At first we give the whole mind to an act, but repetition makes it easier, until it can be done without the aid of the mind, except to start it. Every well-formed habit alters the nerve cells for the remainder of life.

7. **Thinking.** — Thinking is closely associated with nerve action. Good nerve cells make it possible to do good thinking, and diseased, hungry, or tired cells make it impossible. Thinking is scarcely the work of a definite part of the brain, but the act is usually thought to be the work of the frontal region; the fact is, thinking calls into use almost the entire brain: it calls up past impressions of sense with which to make the new ideas. It stores up new

thoughts and the old sense impressions in what we call memory. Thinking, then, is directly or indirectly a part of the great work of the nerves.

8. **Speech.** — Speech is both a motor and mental act. It is the act of expressing a thought in words. The mind, through speech, may make new sensory and motor ideas, and from these make new thoughts without calling the nerves of sensation into use. Man can use the sensory and motor idea of others, and make new ideas of his own; he can learn by the experience of others. Spoken words are made in part by using the centers of the nerves of the face, but there is a special center of speech located low down in the front part of the motor area of the brain. When it becomes diseased, the power of speech is impaired or lost. Speaking is very complex, since it involves thought, and thought may call into play nearly all brain centers. Every emotion modifies it.

9. **The Will.** — The will is the mental power which chooses, holds a choice, and executes it. The will is moved by the emotions, the judgment, and the animal impulses. Knowledge precedes emotions, and emotions usually precede the will; so an act of will follows all other acts of mind, and sometimes follows the acts of the body; the will therefore calls into play the whole mind at one time or another. Almost every center in the body may be made to answer the dictates of the will.

The will, then, is related to the work of the nervous system. One who drinks alcohol to excess injures his brain, and may almost destroy the will.

OUTLINE SUMMARY

1. *Function of Spinal Cord.* 1. A second brain — great center of reflex action.
   2. Intelligence — proof insufficient.

3. Gray matter — originates impulses.
4. White matter — transmits impulses.

2. *Work of Sympathetic System.* 1. In vital action — aids or directs nearly all vital processes.
2. Sympathetic action — when one organ is diseased, the function of another may be upset.
3. Source of force — gets force from spinal cord.

3. *Reflex Action.* 1. Definition — an act of the lower centers. Explain.
2. Organs — three: end organ, nerve fibers, and center.
3. Acts — five. Make statement.
4. Examples. Make statement.
5. Automatic reflex acts — beating of heart, peristalsis, etc.

4. *Volitional Action.* 1. Higher form of nerve action — voluntary, or volitional action.
2. Power — may counteract a reflex act. Make statement.

5. *Sleep.* 1. Definition — a natural state of unconsciousness.
2. Result — stops waste and aids repair.
3. Quality — should be perfect.

6. *Habit.* 1. Basis — the law that cells tend to repeat their act.
2. Effect — altered size, efficiency, and sometimes shape of cells.
3. Value — lies at basis of all skill.
4. Education — the making of good habits.

7. *Thinking.* 1. Relation to nerve action — intimately associated with it.
2. Dependence — good cell action depends somewhat upon mental states, and good thinking requires good nerve action.

8. *Speech.* 1. A combined act — mental and sensory.
2. Value — enables one to use the experience of others.
3. Speech center — located down in the front part of motor area of brain.
4. Disease — disease of the center may impair or destroy speech.

9. *The Will.* 1. Definition — the power of the mind to choose, to hold a choice, and to execute it.
2. Strength — the will is related to nerve action to some extent. Alcohol used to excess may destroy the will.

CHAPTER XXXIX

HYGIENE OF THE NERVOUS SYSTEM

1. Nerve Foods. — Nerves get their nourishment from all good foods, as all other tissues do. The health of nerves depends more upon their nourishment than upon anything else; this requires good foods, well cooked

and well served, and good work in every vital process. Most brain disorders come from two causes: (1) improper nutrition, and (2) poisons. It is, therefore, necessary to nourish the nerves well, keep out all poisons, and remove the poisons of the body as fast as they are made. If we keep out poisons that do not belong to the body, and live a simple life, we can easily dispose of the poisons the body makes.

2. **Effect of Emotion.** — The states of the mind affect the body. They first affect the nervous system, and through it either improve or impair digestion, respiration, circulation, and the secretions. Sadness, anger, and fear affect all vital processes, and in time may almost destroy health. Joy, love, and happiness aid all the vital processes, and therefore aid good health. Strong passions will do much to destroy health, if they are not under control. Grieving over misfortune may kill; it is possible for one to die of a broken heart.

3. **Fear.** — Fear is an excited state of mind due to a belief in great danger. The nervousness is great, and sometimes upsets the judgment; confusion usually follows fear, and one is likely to become panic-stricken, and run headlong into danger. This is seen in people trying to escape from a burning building, from a dangerous stream, or a violent storm. Self-possession is a result of thought and training. The nervous exhaustion from fear is so great that illness, and even temporary insanity, may follow.

4. **Habit.** — Habit is a strong force in making good nerves or bad nerves. Habit can override the will and break it down. Habits for good and bad become automatic, and it is almost impossible to break them. An old

man whose habits are fixed cannot do things contrary to his habits, and usually cannot think things that are foreign and opposed to his habits. Bad habits of work, thought, and passion break down the nervous system, and defeat life's aims. Bad habits are the cause of much insanity. A little thinking about good habits, and what habits to form, will do much to make good health and a noble life.

5. **Heredity.** — By heredity the nervous conditions of parents descend to their children. If one's parents are criminal or diseased, he may have a tendency in that direction; the children of good, healthy parents are naturally inclined like their parents in both body and mind. We do not inherit a parent's disease, but we do inherit altered cells due to a parent's disease or dissipation. By training, one can outgrow and overcome what he inherited. The children of parents who had consumption or fits can be trained until they will not have these diseases.

6. **Great Strain.** — Continuous strain soon shows its effects in the nervous system. Vigorous, useful work is an essential of health; it does not wear out the nerves, but helps make them strong. It is necessary that there be variety in both mental and physical work, and recreation must accompany both. Work should be so changed and recreation so intermixed as to enable one to carry on his duties continuously without vacation. It is worry that kills, not work. Vexation and discouragement may break down the nervous system long before its time. Every nerve cell in the body should be called into play every day; when we worry, we are using only a part of our cells, and using them all the time. They will soon break down. We should throw off our painful cares, for our own sakes, if it is possible.

7. **Rest.** — Fully one half of all our time must be spent in rest, eight hours of which should be spent in restful, unbroken sleep. All hard workers must have some diversion; brain workers should have some inspiring games, both indoors and out. All workers should cultivate the habit of light reading to alternate with the heavy thought of real work, and indulge heartily in a good social life. Not more than one third of one's time should be spent in hard work, unless a little recreation can be intermixed during the long hours of toil; then, when one does work, he should do it with all his might, not wastefully, but well. Rest should never amount to dissipation, but should lead to renewed power. Athletics, the manual arts, or the sports of hunting and fishing should become a part of every one's life. Sports should be kept clean and dignified. Working with edged tools for a short time each day has prolonged many a life. Our recreation, as far as possible, should be taken in the sunshine and fresh air.

8. **Sleeplessness.** — Regular, restful sleep is a great fortune. If we lose or break sleep, we will have to pay the debt sometime; it may come in the form of lost power, bad health, or a shortened life. There are many things that destroy sleep, among which are the following: —

(a) *The Wrong Time.* — Persons in good health should not sleep in the day; night is the proper time. One should awake at daybreak, and retire early in order to get enough sleep. A student loses ground by sitting up too late; he is weaker next day, and his work loses quality. A nervous person should sleep a few minutes, not more than fifteen or twenty, about noon, and thus break the strain of the day.

(b) *Worries at Night.* — Taking cares and troubles to bed is a bad habit. After retiring, the mind should not be *permitted to* think over the work and worries of the day.

This can be controlled by an effort of the will. Set the mind to thinking about something pleasant, or something light; as soon as we can fix our attention on one thing, we shall fall asleep; another good way is to imagine some action or motion in which counting can be employed, as counting sheep as they jump through a break in a fence, or counting the cross ties in an imaginary railroad.

(c) *Congested Brain.*—Too much blood in the head will prevent sleep; a light lunch may draw away the surplus blood. A better plan is to equalize circulation; it can be done by a hot footbath, or a warm body bath; the same effect can be got by taking a cold bath, and then rubbing the body briskly to cause a reaction in which surplus blood is brought to the surface. A friction bath is good; remove all clothing and rub the body with a rough towel until the skin is red; this will bring the blood to the surface. Some medicines can be taken to overcome sleeplessness, but this course should be adopted only upon the advice of a physician.

(d) *Idleness.*—This is a prominent cause of sleeplessness. If one is idle continuously throughout the day, it is difficult for him to sleep. When one retires from active business, especially in old age, insomnia usually sets in. It is necessary for the body and mind to be somewhat fatigued before one can sleep well.

(e) *Narcotics.*—Some drugs produce sleep; but if the habit is once formed, one cannot sleep without them, and the last state is worse than the first.

(f) *A Congested Stomach.*—A full stomach will cause wakefulness, and nearly always causes bad dreams. Gas in the stomach should be relieved promptly.

9. Dreaming.—In a dream, disordered motor and sensory images are called up and out, and seem to be

real; the imagination lends a hand, and some very strange images are made. These images can move the will and make one act while yet asleep.

Sound sleep is never accompanied by dreams. Dreams require so much nerve force that when one wakes he feels tired, especially if the dream is exciting. Dreams may be caused by joy, sorrow, sickness, pain, a disordered digestion, bad circulation, alcohol, heat or cold, and many local conditions. One can form the dream habit. As a general thing, a person can control or prevent dreaming by removing the cause. The will is of great help in preventing dreams. One should not make a practice of telling his dreams to others, as this keeps up the habit.

Nightmare is a form of dreaming in which the dreamer thinks he is in great danger and cannot help himself; it is usually caused by bad circulation. *Somnambulism* is another form of dreaming in which the dreamer gets up and walks, climbs, or engages in some customary labor. The centers of muscular action are stimulated by the dream, and habit gives direction to the action.

OUTLINE SUMMARY

1. *Nerve Foods.* 1. General — nerves get nourishment from any good food.
   2. Cause of nerve disorders — two: improper nourishment and poisons.
2. *Effect of Emotion.* 1. Nerves — emotion first affects nerves, then all vital functions.
   2. The psychic power — very great. Make statement.
3. *Fear.* 1. Definition — excited state of mind due to belief in danger.
   2. Danger — confusion and panic; may lead to illness.
4. *Habit.* 1. Power — almost irresistible when well formed.
   2. Bad habits — break down the nervous system, destroy health.
5. *Heredity.* 1. Inheritance — not disease, but weakness, or strength.
   2. It may be overcome — by training.
6. *Great Strain.* 1. Effect — continued strain will break down the nerves.

2. Worry — it kills, but useful, inspiring work gives vigor.
3. Relief — comes from a change of work, not suspension.

7. *Rest.* 1. Amount — fully one half of life; this is nature's law.
2. Dissipation — rest should never become dissipation.
3. Diversion — all hard workers should have it regularly.
4. Athletics — properly indulged, will save many a life.

8. *Sleeplessness.* 1. Causes — wrong time, worry at night, too much blood in head, idleness, narcotics, congested stomach, and disease.
2. Results — lost vitality, reduced power, and shortened life.

9. *Dreaming.* 1. Definition — unconscious cerebration, made up of disordered motor and sensory images.
2. Cause — some abnormal mental or physical state.
3. Result — loss of power, both mental and physical.
4. Unusual forms — nightmare and somnambulism.

CHAPTER XL

DISEASES OF THE NERVOUS SYSTEM

1. False Pain after Amputation. — It is said that a foot will ache after it is cut off. The patient for a short time may have the same pain he had before the operation. This is due to the exposure of the same sensory nerve that carried the impulse of pain before the operation; it will continue to ache until protected, removed, or reduced until it cannot feel the irritation.

2. Nervousness. — Nervousness is due to a tired or diseased brain. When the brain loses much of its energy, the feelings are not under control, and physical acts are not in proportion to their stimuli. To overcome this the patient must have rest, nourishment, freedom from excitement, and sympathy. A nerve tonic may be necessary. If the patient be a pupil, the teacher should not permit him to be scolded or unduly criticised; his work should be lightened.

3. Alcoholism. — This is the name of the nervous disease caused by excessive use of alcohol. In its action

upon the nervous system, alcohol produces three effects: (1) stimulation, (2) loss of mind, and (3) paralysis.

In the first stage, the blood circulates freely, food is carried to the brain and tissues, producing increased mental action and a good feeling; there is a gentle excitement, making a vivid imagination, a glib tongue, and a generous feeling. Men who drink for the effects of alcohol usually try to get the first stage of intoxication; public speakers sometimes do this. Even in this stage there is a loss in the moral sense and a weakening of the will.

In the second stage, the action of nerve cells becomes uncertain; they act, but the brain has lost control. The cells are like a team without a driver; a bad feeling takes the place of the good one of the first stage; the drunken man wants to fight and to kill. In this stage the intellect is clouded, the moral sense is almost gone, and the will is stormy. Then the motor regions fail to act, and the patient loses the power of motion and speech.

In the third stage there is complete unconsciousness and paralysis; intelligence, moral sense, will, motor power, and sensory power are gone, and the patient is a temporary wreck. The action of the medulla is all that has not been overcome; circulation and breathing are all of life that are left; at this point a little disturbance of respiration will cause the heart to stop. Many men die in this stage.

In continued drinking, however slow, the stages of a single intoxication are gradually made permanent. One is at first permanently affected as in the first stage; if continued, then the effects of the second stage, and finally those of the third stage, become permanent. Alcoholism overcomes the victim completely, and he is a wreck. The mind and will have lost their power over the patient's action, and he becomes an object of pity. There is a treatment called the "whisky cure" which physicians may

give. But the patient can be cured by abstinence, the influence of good companions, good literature, and encouragement. The only safe way is to keep the patient away from the people and places connected with alcohol, and refuse under all circumstances to let him touch it. A person with chronic alcoholism is a changed being; he is only a shadow of his former self; nearly all the nerves of his body have been altered. He must be almost made over again before he is proof against the terrible appetite for strong drink.

4. Delirium Tremens. — Delirium tremens is a disease of the nervous system caused by drunkenness. The sensory regions of the brain gain control, and the state is similar to nightmare, only much worse. The patient imagines that he is in the presence of dangerous reptiles that are trying to attack him, and that he cannot escape. He will talk, scream, and cry for help. This awful state of the mind frequently lasts for days or months, and sometimes ends in death. The treatment is the same as for chronic alcoholism. It never leaves a person unharmed. He may be partially cured, but the patient can rarely attain his former strength.

5. The Drug Habit. — By the drug habit, we mean that craving for a drug that cannot be satisfied by anything else. It is the result of the use of the drug; the nerves are so altered that they cannot do without it. It is a law of cell life that when a drug is used a few times, the cells get so they can stand more and more of it, then they get so they cannot do without it. Opium, morphine, cocaine, and many other drugs have this effect upon the nerves. These drugs affect the mind also, and any one who uses them will fall a victim sooner or later. There is at first the craving of the cells, then the clouding of the intellect,

then the failure of the moral sense, the will, and finally the yielding of the body to disease.

6. Opium and Morphine. — Such drugs as these are very useful, but very dangerous, and should be taken only when a physician prescribes them. They have a soothing, quieting effect upon the nerves, and soon gain control over them. They poison the cells, cloud the intellect, deaden the moral sense, destroy the will, and reduce those who acquire the habit to slaves. Such persons will sell anything they have or resort to any trick to get the drugs. There are cases of the drug habit that were pretty well begun by taking only one dose of morphine. The only way to be safe is never to take them.

7. The Medicine Habit. — Even with harmless drugs, the habit of "taking medicines" can be formed; the nerves will at first tolerate more and more of a drug, then demand it. A good rule is never to take a medicine until it is needed for a definite purpose, and to cease taking it as soon as its effects are obtained. Any medicine habit will lead to bad health. Such a good medicine as quinine, useful for so many things, can be taken for every little ailment until the quinine habit is formed.

OUTLINE SUMMARY

1. *False Pain after Amputation.* 1. Example — toothache after extracting tooth.
   2. Cause — exposure of some nerve that reported the toothache.
   3. Cure — protect, remove, or shrink the nerve.
2. *Nervousness.* 1. Cause — usually tired brain, or disease in brain.
   2. Cure — rest, good food, freedom from excitement, sympathy, and sometimes change of scenery.
3. *Alcoholism.* 1. Definition — a nervous disease caused by use of alcohol.
   2. Effects of alcohol on nerves — three: stimulation, aberration, and paralysis.
   3. Permanent effects — temporary effects become permanent.
   4. Cures — two: "whisky cure" and abstinence.

4. *Delirium Tremens.* 1. Definition — a disease of the nerves caused by drunkenness.
   2. Delusion — patient imagines himself attacked by reptiles and cannot escape.
   3. Cure — same as chronic alcoholism. Patient never fully recovers.
5. *The Drug Habit.* 1. Definition — a morbid craving for a drug.
   2. How formed — by increasing the amount of a drug used.
   3. Effects — destroys function and health; sometimes causes loss of mind.
6. *Opium and Morphine.* 1. Effect — soothing to nerves; very useful, but very dangerous.
   2. Destruction — continued use poisons the cells, clouds intellect, deadens the moral sense, and destroys the will.
7. *The Medicine Habit.* 1. Definition — a state in which the nerves require medicine, either from habit or sentiment.
   2. How to prevent — take a medicine only for a definite result, and discontinue when the result is obtained.
   3. Example — the quinine habit.

CHAPTER XLI

DISEASES OF THE NERVOUS SYSTEM (*continued*)

1. Coffee. — The drinking of coffee, tea, and many similar drinks, not at first harmful, produces the drug habit finally. They have at first a stimulating and then a soothing effect upon the nerves; finally, they fasten themselves upon the constitution and injure it. No one should ever use them to such an extent that they cannot be abandoned without headache and nervousness. Children should never use them, and middle aged people seldom need them; old people may use them moderately for their first effect. Their final effect is sleeplessness and nervousness; then they will affect digestion and the other organic processes, and at last impair or destroy health. An unusually strong constitution may bear the coffee habit through a long life, but it will never be so strong as it would have been.

2. **Tobacco.** — The nicotine in tobacco is a poison; it affects the nerves of every one who uses it. Some people can use it with but little bad effect, and enjoy it because it soothes the nerves; but later it usually produces nervousness, indigestion, sleeplessness, and tremors. It sometimes affects vision. It can do no good, is not needed, and therefore in the end can only do harm. It is another form of the drug habit.

3. **Injuries.** — The effect of an injury upon the head or cord depends upon the place and the extent of the injury; any injury upon the top of the head is serious, and at the base in the region of the medulla it is usually fatal. If the injury itself is not serious, a blood clot frequently forms because of disabled nerve tissue. A clot is always dangerous. Injuries to the cord usually produce paralysis and disordered function in some vital process. In all such cases, have a physician.

4. **Delirium from Fever.** — Fever is caused by poison; any poison may affect the mind. Delirium frequently comes with fever, both being the result of poison. This delirium is usually temporary, and leaves with the fever. In case the poison is very great, the delirium may remain for a time.

5. **Neurasthenia.** — This is the scientific name for "nerve prostration," our "national disease." It is caused by bad heredity, faulty nutrition, dissipation, other diseases, and overwork. Great strain, anxiety, worry, infectious diseases, tobacco, alcohol, and idleness are prominent causes. Brain workers are more liable to it. It is not mere exhaustion, but a disease. It can be cured only by removing the cause, the use of nerve tonics and foods, correct hygiene, and rest, with light diversion. Diet is very important.

6. **Hysteria.** — Hysteria is a mental disease usually partly inherited, and caused by some brain or nerve injury, some other disease, fright, disappointment, great grief, religious excitement, or alcohol. It is more common in women than in men. The symptoms are various, such as surface spots too sensitive or too numb, jerking of muscles, strange movements, temperature too high or too low, craving for sympathy, sighing, choking, and paralysis. There is a certain amount of fraud in it; for instance, when the patient falls, he usually prepares for it. Treatment consists in regulating the mind, and the use of appropriate drugs. The graver forms are incurable.

7. **Insanity.** — Failure of the brain to work properly, and loss of control over mental actions are known by the general name of insanity. There are many forms of it. It is caused by disease, overwork, worry, nerve prostration, and alcohol. It is sometimes inherited. In the treatment, rest is important; the cause must be removed, if possible, and the particular trouble treated. Many cases of ordinary insanity are curable. The patient usually thinks that other people are crazy.

8. **Epilepsy.** — Epilepsy is caused by inheritance, bad nutrition, and alcohol; the common cause given for it is poison. The patient usually has fits of various types. In its worst form it is incurable. The patient may be improved or cured by diet, removal of poisons, and proper exercise.

9. **Apoplexy.** — If the arteries of the brain harden and crack, the blood flowing out on the brain causes apoplexy. It comes in the form of a stroke of paralysis. The possibility of recovering depends upon the location and extent of the injury. The attack is usually fatal. It may be caused by a violent fit of coughing, by anger, or

anything else that causes a heavy flow of blood to the head.

10. Paresis. — This is the general paralysis of the insane, and is incurable. It begins by the patient's making some great, impossible plan, like uniting all the kingdoms of the world in one; this is usually followed by violent spasms, efforts at self-destruction, collapse, and death. It is caused by bad inheritance, alcohol, other bad diseases, and high living.

11. Anæsthesia. — For surgical purposes, ether and chloroform are used to produce sleep. When inhaled, they produce a state something like a very deep sleep; sensation is gone; the surgeon can operate, and the patient never feel it. Breathing and circulation are the only signs of life. At the proper time the patient will awake very much as if awaking from a sleep, after the operation has been finished, and the wound dressed. One can remain in this condition for several hours.

12. Aphasia. — This is a disease due to the disturbance of the speech centers of the brain. The patient usually cannot talk; he tries to speak one word, and another comes; he can understand spoken or written words, but cannot always speak them; in another form of it, the person is able to speak or write a word, but not able to know at sight a familiar word; again, one cannot speak his words, but can write them and then read them.

13. Senile Dementia. — This is the fading out of the mind of a very old person. There are several stages: (1) primary, when the patient becomes very childish; (2) secondary, when the patient may have a mild insanity; and (3) tertiary, when paralysis and the fading out of the mental powers occur.

14. Functional Insanity. — This is temporary, or at least it comes and goes. It is due to derangement of some of the organic processes. It is usually curable. Its treatment consists in restoring lost function.

OUTLINE SUMMARY

1. *Coffee.* 1. Effect — first a gentle stimulant, then soothing effect.
   2. Nature — not a food, but a drug; final effect is injurious.
2. *Tobacco.* 1. First effect — soothing.
   2. Final effect — bad; produces nervousness, insomnia, tremors, and sometimes bad sight.
3. *Injuries.* 1. Seriousness — depends upon place in cord, or region of the head, and extent.
   2. Blood clot — even slight injuries are frequently attended by dangerous blood clot.
4. *Delirium from Fever.* 1. Cause — poison; it is usually temporary and not very serious.
   2. Treatment — if tendency to become permanent, treat the poison.
5. *Neurasthenia.* 1. Cause — bad inheritance, bad nutrition, overwork, etc.
   2. Treatment — remove cause; tonics, diet, correct hygiene, rest.
6. *Hysteria.* 1. Definition — a mental disease due to cortical disturbance.
   2. Causes — numerous. Make statement.
   3. Symptoms — many. Make statement.
   4. Cure — regulating the mind, and appropriate drugs.
7. *Insanity.* 1. Definition — failure of brain to function.
   2. Causes — numerous. Make statement.
   3. Treatment — rest an important factor; remove cause.
8. *Epilepsy.* 1. Definition — a nervous disease due to poison.
   2. Cure — in worst form it is incurable.
9. *Apoplexy.* 1. Cause — pressure upon the brain by bursting a blood vessel.
   2. Result — usually fatal; attack sudden, and usually appears in form of paralysis and unconsciousness.
10. *Paresis.* 1. Definition — general paralysis of the insane.
    2. Cause. Make statement.
    3. Form — mental excitement, spasms, efforts at self-destruction, collapse, and death. It is incurable.
11. *Anæsthesia.* 1. Definition — a deep unconsciousness.
    2. Drugs — chloroform and ether.
12. *Aphasia.* 1. Definition — partial loss of speech due to disturbance of speech center.
    2. Forms — several forms. Make statement. Usually curable.

13. *Senile Dementia.* 1. Definition — the gradual decline of the mind in old age.
   2. Stages — three: primary, secondary, and tertiary. Incurable.
14. *Functional Insanity.* 1. Definition — derangement of mind due to functional troubles.
   2. Treatment — restoring lost function. It is curable.

CHAPTER XLII

THE EYE

1. The Senses. — Our knowledge of the physical world about us is gained through sight, hearing, taste, smell, and touch. The organs that do this work are end organs of the great nerves, each adapted to a special form of sensation. These organs and the special work they do are called the "Special Senses."

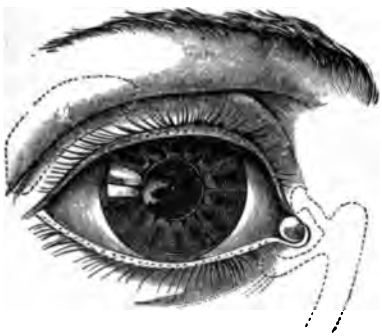


FIG. 58. — The eye.

2. The Eye. — The end organ whose special work is vision, or sight, is the eye. It is a hollow globe filled with a fluid. The eye is the most perfect optical instrument in existence. The eyes occupy the two cavities, one on either side of the nose, called orbits.

3. Protecting Parts. — So delicate and so useful an organ as the eye requires very great protection. The eye is protected by the overhanging brow, by the eyebrows, by the soft structure around the ball, by the eyelids, by eyelashes, and by the lining membrane of the eyeball and *eyelids.*

4. The Eyeball. — The size of the eyeball varies, but it is about an inch from side to side, and something more than an inch from front to back. The motion of the eye is supplied by a set of six muscles. The eye has three coats, and its hollow is filled with three transparent substances called humors. The skin on the outside of the eyelids turns in at the edges of the lids, lines the inside of the lid, and is reflected upon the eyeball, covering it also. This lining of the lid and covering of the ball is called the *conjunctiva;* it is very sensitive, and pains us when we get a foreign body in the eye. There is a nerve entering the back part of the eye and connecting it with the brain; it is called the optic nerve.

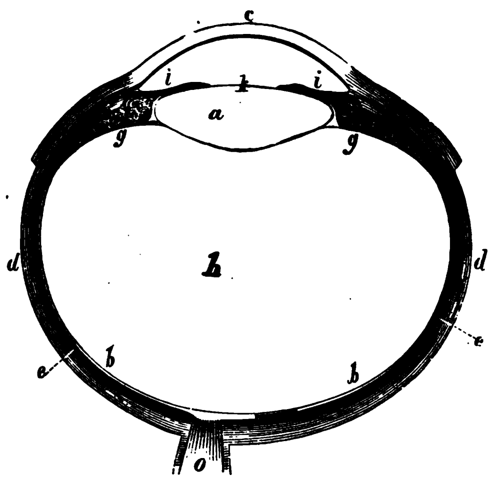


FIG. 59. — The eye.

d, sclerotic coat; *e*, choroid coat; *b*, retina; *o*, optic nerve; *a*, crystalline lens; *g*, ciliary processes; *h*, vitreous humor; *k*, pupil; *i*, iris.

5. The Coats. — The three coats of the eye are (1) the outer, or *sclerotic*, (2) the middle, or *choroid*, and (3) the inner, or *retina*.

The *sclerotic coat* has two parts, one in the rear, covering about five sixths of the ball, and one in front, covering the remaining sixth. The larger one is a very tough, strong membrane, hard enough to hold the eye in shape, somewhat elastic, and white in color; the part of it we see is

called the white of the eye. There is at the back a small opening through which the optic nerve enters. The front sixth of the outer coat is a transparent body called the ***cornea***, which fits into the circular edge of the sclerotic coat like the crystal of a watch, and completes the coat. The cornea is covered by the conjunctiva, which is perfectly clear, the window that lets the light into the eye.

The *choroid membrane*, or second coat, is made up of two parts. Like the outer coat, about five sixths is a continuous membrane lining the outer coat; it is a dense network of capillaries, and contains pigment cells that give it a dark brown color. At the edge of the cornea, the choroid coat is crimped into a series of folds called the *ciliary processes*, beneath which is the ciliary muscle. Just behind the cornea is hung a curtain called the iris, which, with the ciliary processes, completes the choroid membrane. In the middle of the iris is a circular opening called the pupil. The iris contains pigment which gives color to the eye; it is supplied with two sets of muscular fibers, one circular and one radiating; these muscles regulate the size of the pupil, and adapt it to the light.

6. Retina. — The retina, the inner coat of the eye, is really an expansion of the optic nerve, a nervous coat lining almost the entire inner surface of the eyeball. It has ten layers, the one next to the outside layer being called Jacob's membrane, and made up of "rods and cones," the termination of the optic nerve. These rods and cones are very small, and help to make vision.

7. The Humors. — The humors of the eye are (1) the *aqueous*, (2) the *vitreous*, and (3) the *crystalline lens*.

The *aqueous humor* is a fluid, occupying the cavity between the cornea and crystalline lens. The iris is suspended in this fluid. The aqueous humor is a transparent

liquid very much like water; when the cornea is punctured, it runs out, destroying sight. The cavity usually fills up again when the cornea is healed, and the sight is sometimes restored.

The *vitreous humor* fills the large internal cavity within the retina; it is transparent, thick, like gelatin, and inclosed in a kind of bag called the hyaloid membrane.

The *crystalline lens* is a double convex lens, and, with the aqueous and vitreous humor, constitutes that compound lens, or series of lenses, that make vision possible; it is not a fluid like the other humors, but a solid elastic body, inclosed in a transparent capsule or bag, which is attached to the sclerotic coat near the rim of the cornea. In front of it is the aqueous humor, and behind it the vitreous humor. The muscles about it change its shape in order to alter its images.

OUTLINE SUMMARY

1. *The Senses*. 1. Forms — the five senses.
   2. Organs — end organs of great nerves.
2. *The Eye*. 1. General description — a hollow globe, filled with a fluid.
   2. Location — side of base of nose.
3. *Protecting Parts*. 1. Necessity — such a delicate organ requires perfect protection.
   2. Names — brow, eyebrows, soft structures, eyelids, eyelashes, and lining membrane.
4. *The Eyeball*. 1. Size — an inch or more in all its diameters.
   2. Motion — supplied by a set of six muscles.
   3. Coats — three.
   4. Humors — three.
   5. Membrane — lining of lid and covering of ball.
   6. Nerve — the optic nerve entering the rear of the ball.
5. *The Coats*. 1. Names — the sclerotic, choroid, and retina.
   2. The sclerotic — first coat, two parts; it has an opening in the back part; the cornea. State fully.
   3. The choroid — second coat made up of parts; a dense network of capillaries; pigment; ciliary processes and iris complete the membrane; the pigment of iris gives color to eye. The pupil is an opening in the iris; the iris has two sets of muscles.

6. *Retina.* 1. Definition — inner coat of eye; an expansion of the optic nerve.
   2. Layers — ten, one called Jacob's membrane being the chief organ of vision.
   3. The yellow spot — the point where vision is best. (See page 264.)
   4. The blind spot — where the optic nerve enters the eyeball.
7. *The Humors.* 1. Names — aqueous, vitreous, and crystalline lens.
   2. Aqueous — a clear fluid between cornea and crystalline lens, in which the iris is suspended.
   3. Vitreous — a fluid like gelatin; fills the large hollow within the retina.
   4. Crystalline lens — a double convex lens; it is a solid, elastic body about one third of an inch long.

CHAPTER XLIII

THE WORK OF THE EYE

1. The Pupil. — The work of the pupil is to make upon the retina an image or picture of the object seen. When the circular fibers of the iris contract, the pupil is made smaller; and when the radiating fibers contract, the pupil becomes larger. In the dark the pupil becomes very large, and in a bright light it is very small. When the day is bright and snow is on the ground, the excessive light contracts the pupil until one can scarcely see on entering a house. The pupil may become too large or too small to see well. The contraction of the muscles of the iris enables the eye to adapt itself to light, the iris serving very much the same purpose as the curtain of a window.

2. The Tears. — The tear organs are the *tear glands*, *tear ducts*, *tear canals*, *tear sac*, and the *nasal duct*. The tear gland is located just above the outer corner of the eye, and secretes a fluid called tears which is discharged upon the eyeball. A surplus of tears is gathered up by two little tear canals at the inner corner of the eye and

carried to the lachrymal sac, and from there to the nose by the nasal duct, where it evaporates. (See Fig. 58.) If tears are too abundant, they flow over the lids upon the face. The tears are a sort of salt water, with three uses: (1) to keep the eye moist, (2) to protect the eye against dust and foreign bodies by washing them away, and (3) to reduce inflammation by the salt contained.

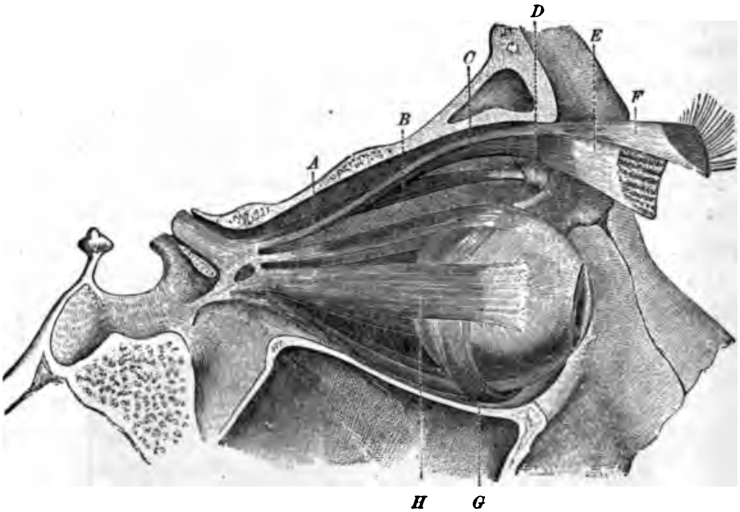


Fig. 60.—The muscles of the right eye.

A, superior rectus; *B*, superior oblique passing through a pulley, *D*; *G*, inferior oblique; *H*, external rectus, and, back of it, the internal rectus muscle.

3. Movement.—The movement of the eyeball is brought about by its six muscles; they are (1) the *external rectus*, which turns the eye outward, (2) the *internal rectus*, which turns it toward the nose, (3) the *superior rectus*, which turns it upward, (4) the *inferior rectus*, which turns it downward, (5) the *superior oblique*, which rotates the eye inward or turns it outward and downward, and (6) the *inferior oblique*, which rotates the eye outward, and turns

it inward and upward. The muscles all work in pairs; when one contracts, its mate relaxes. Sometimes one muscle is too strong or too short for its mate, and the eye is drawn out of line, causing "cross eyes."

4. Sight. — The eye is constructed very much like a photographer's camera, which has four essential parts: (1) openings to let in the light, (2) a lens to focus the light from the object, (3) a sensitive screen to receive the image, (4) dark walls inside to absorb all rays from other objects. The sensitive plate is made of a chemical substance which light will change; as soon as the outline of the image falls on the plate, the image is actually made by the action of light on the sensitive plate. This is exactly what takes place in the eye; the pupil lets in the light, the humors of the eye are the lens, the retina, the sensitive plate, and the choroid membrane, with its dark brown sides, answers for the dark walls within the

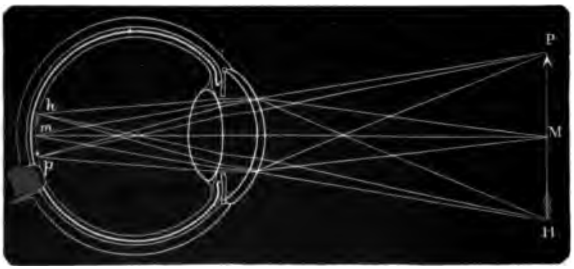


FIG. 61. — Formation of an image on the retina.

box. The lens brings the light's rays from the image to a focus on the retina, in which there are minute particles of brown coloring matter that are instantly changed by light; an image is thus made, which the retina sends to the brain as a sensory impulse, and in some mysterious way it *appears as* an image of the mind.

5. Light. — A sunbeam is composed of seven colors, like the colors of the rainbow, which are red, orange, yellow, green, blue, indigo, and violet. When a ray of light passes through a lens, it is bent out of its course. The shape of the lens may scatter the rays as they pass through it, or bring them all together to one point called a focus; the latter is what the lens of the eye does; it throws the focus upon the retina, by which an image or picture is made, just as it is in the photographer's camera.

A surface that reflects all the colors in light is white, and one that absorbs all the colors is black. When a surface reflects any one ray, as green, it is said to have that color.

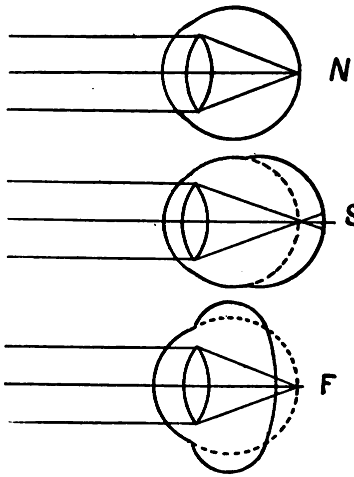


FIG. 62. — Diagram showing how rays of light from distant objects are focused.

N, in a normal eye, on the retina; *S*, in a short-sighted eye, in front of the retina; *F*, in a far-sighted eye, in which they reach the retina before they come to a focus.

6. Field of Vision. — The field of vision is the space in which objects are distinct; things are distinct only in a small field directly in front of the eye and only a short distance, the distance depending upon the eye's power to focus. Many things lying just out of the field can be seen, but not distinctly.

7. Accommodation. — Objects within the field of vision can be seen with almost equal distinctness, whether near or far from the eye. To do this, either the lens must be movable, so it can be brought closer and moved farther

away from the sensitive plate, or the shape of the lens must be changed, so the focus will fall on the sensitive plate; the former is what is done in the camera, but the latter is done in the eye. The shape of the crystalline lens is changed by the muscles about it. To see an object very near, the lens must be more convex, and for an object far away it must be less convex. This is necessary to make a distinct picture, and is called *accommodation*. A normal lens cannot accommodate for an object nearer than about five inches.

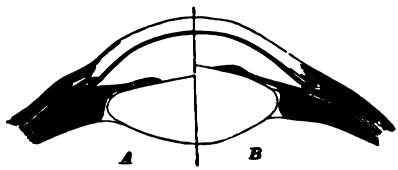


FIG. 63. — Adjustment of the crystalline lens. *A*, for far objects, and *B*, for near.

OUTLINE SUMMARY

1. *The Pupil.* 1. Work — to make image upon retina.
   2. Muscles — two sets of fibers, one circular and the other radiating.
   3. Variation in size. Make statement.
2. *Tears.* 1. Organs — gland, tear ducts, canals, sac, and nasal duct.
   2. Uses — to keep eye moist, to protect against dust, and to reduce inflammation.
3. *Movement.* 1. Muscles — six. Make statement.
   2. Failure of muscles to accommodate — "cross eyes."
4. *Sight.* 1. The camera — four parts. Make statement.
   2. Similarity of eye to camera. State the points of similarity.
   3. Process. Make statement.
5. *Light.* 1. Prismatic colors — seven.
   2. Reflection — reflection of a given ray gives an object the color of that ray; when all rays are reflected, the object is white.
   3. Absorption — when all rays are absorbed, the absorbing object is black.
6. *Field of Vision.* 1. Limits — very small, only a short distance in front of the eye; determined by the eye's power to focus.
   2. Meaning — space in which objects can be seen *distinctly*.
7. *Accommodation.* 1. Manner — done by changing shape of crystalline lens to make focus fall on retina.
   2. Changes in lens — more convex for objects near, and less convex for distant objects.

QUESTIONS

1. What are the organs of the special senses?
2. Name the parts of the eye.
3. Compare the eye to a photographer's camera.
4. Describe the retina.
5. What causes the size of the pupil to change?
6. What is the cause of "cross eyes"?
7. What is the field of vision?
8. What are the prismatic colors?
9. What is accommodation?
10. What is the work of tears?

CHAPTER XLIV

HYGIENE OF THE EYE

1. Duration of Images. — The image of an object remains from one tenth to one fourth of a second after the object is removed from sight; usually the eye will make a distinct image in one tenth of a second; moving pictures, flying birds, moving light, or waves on the beach can be seen distinctly if they are moving no faster than that rate. Two colors moved together faster will blend. Attempts to see objects in rapid motion will injure the eye.

2. Judgment of Position. — One has trouble to judge of distance with one eye. When both eyes look at the same object, the images made by the two eyes are not exactly alike, because the eyeballs are not in the same place. The images have to be blended; this enables one to form an idea of position and distance. The same trouble comes to some extent from bad focusing; it may be corrected by glasses in which the lenses are different.

3. Direction and Quantity of Light. — Looking at the sun, any reflected light, or snow in the sunlight, is very hard

on the eye. We see things in the broad light of day without injury, because the eyes are protected against rays that come directly into them. Looking at a light window will injure the eye, but looking through it at other objects will not, for the reason given. Light should come from the side, or from the back, in such a way as to shield the eye from any direct ray. This rule cannot be followed too closely. Direct rays, or lights too bright, exhaust the retina and injure the sight. One should not read in the twilight, or any light too dim, as an hour of thoughtless reading by a dim or fading light may injure the sight for a lifetime.

4. **Exhaustion of Retina.** — The retina is soon exhausted if we look at one object, one color, or one light for a long time; the sight becomes blurred. When we look away at some other object, a lingering image of the former object may obstruct our vision for a moment; in such cases the retina is exhausted, and unable to take up all the new rays until the old image fades out. Such images are called "negative after images." This injures the eye, and can be avoided by frequent rest.

Things appear to have different colors, as they are seen in different light; the sunlight is white, and the light of most lamps is yellow. The best artificial light is the one most like the sunlight; it should be steady and as white as possible. A yellow light may be whitened by a shade. The incandescent electric light, when bright enough, and properly shaded, is perhaps the best to work by. No flickering or unsteady light should be used for close work.

5. **Double Vision.** — A double image of an object appears when one eye is drawn out of its course, or when the *object is in line* with another object at which both eyes are

looking; for instance, if, while looking at an object, we draw one eye out of its course, we shall see two images, as if the object is double; or when two objects near us are in line of sight, one nearer than the other, and we look at either one, the other will appear double. A small object between the eyes and the wall will appear double when our eyes are fixed on the wall. If one eye is closed, one image disappears.

When we look at an object with both eyes, the image of each eye falls on the point of most perfect vision in the retina; at the same time the rays of light from other objects in sight enter the eye, their images falling upon other parts of the retina. The image of the object we are looking at is called the primary, and the others the secondary, image; the mind does not, usually, take up secondary images. So in double vision the mind does not take notice of the secondary image. Imperfect lenses may cause double vision, which can be corrected with glasses.

6. Illusions of Sight. — When the optic nerve is gently irritated, a sensation of light appears; a blow on the head, a fall, and jarring the head, will cause it ; we speak of it as "seeing stars." Such images are sometimes seen on rising from a stooping position. Pressure on the inner side of a closed eye will cause a ring of light. The images of the drunken, delirious, or insane consist in thinking that an object is something else that resembles it. The illusions of moving objects are caused by the eyes losing their relation to some fixed object. A good example is a moving train, when objects seen through the window seem moving in the opposite direction to that of the train, or moving in a circle. The "swimming" of the head, when things about us seem to move in a whirl, and the strange movements of objects during "sea sick-

ness," are good examples of optical illusions. In nearly all illusions of the sight, rest, with closed eyes, is helpful.

7. **Foreign Bodies under Lids.** — Small particles of foreign bodies, like dirt, hair, or grit, in the eye are very painful; the moment they get in, by a reflex act the lids close. In such cases, the eye should not be rubbed, as this only increases the trouble. The lid should be gently lifted by the eyelashes to let the tears wash out the foreign matter. If this does not remove the object, have some one raise the lid or roll it back over a small lead pencil, and remove the object with a soft cloth. Do not pick at foreign bodies if they are embedded in the eye, but call a physician.

8. **Causes of Blindness.** — Many things cause blindness, as an ulcer or wound of the cornea leaving a scar, paralysis of the muscles of the iris causing the closing of the pupil, cataract, granulated lids, and shrinking of the optic nerve. Most of these diseases can be cured, and sight saved, if treated in time.

9. **Granulated Lids.** — The disease known as granulated lids is due to enlarged capillaries; when the eyes are under great strain, the walls of the small blood vessels along the edge of the lids thicken and harden, and the eyes feel as if they had sand in them. The conjunctival covering of the enlarged blood vessels is soon worn through, inflammation sets up, and very bad sore eyes are the result. Some remedy to keep down the inflammation, like salt water or a poultice, should be used, and all matter kept removed until a physician can be seen. The eyes should be protected from the light. The remote cause is defective vision. The physician will remove the enlarged blood vessels, heal the wounds, and correct vision with glasses.

10. Motion and Sight. — A person should not do any close work like reading and needlework while moving. One should not read while riding in cars, as the motion of the car keeps the muscles of the eyes at work constantly; it is a great strain, and finally vision will become blurred. Reading while lying down is a bad habit, because it strains the muscles; the strain may be relieved somewhat by raising the head and holding the book so the eyes are turned toward the feet.

OUTLINE SUMMARY

1. *Duration of Images.* 1. Rate of imaging — $\frac{1}{10}$ to $\frac{1}{4}$ of a second.
   2. Moving objects — require more time to image.
   3. Two or more colors — if they move too rapidly for distinct image, they will blend.
2. *Judgment of Position.* 1. Distance — cannot be accurately determined by one eye only.
   2. Blending — blending of two images of an object is necessary to determine position and distance.
3. *Direction and Quantity of Light.* 1. Quantity — a dazzling, strong, or dim light is injurious.
   2. Position — light should come from the side, or rear.
4. *Exhaustion of Retina.* 1. Negative after images — images remaining for a time after object is gone. They are due to fatigue of retina.
   2. Variety of tints — things appear to change color in different lights.
   3. Light for close work — as nearly like sunlight as possible.
5. *Double Vision.* 1. Cause — one eye drawn out of line, or defect in lens.
   2. Images — called *primary* and *secondary*.
6. *Illusions of Sight.* 1. Forms. Make statement.
   2. Cause — disturbance of retina, disordered digestion, or losing relation to some fixed object of sight.
   3. Cure — remove cause, rest with closed eyes.
7. *Foreign Bodies under Lids.* 1. Pain — due to pressure or injury; small bodies, like particles of dirt, grit, or hair, are very painful.
   2. Removal — do not rub the eye, but raise the lid and let tears wash out the object, or evert the lid and remove object with a soft cloth.

8. *Causes of Blindness.* 1. Injuries and functional disorders — ulcerated cornea, wound of cornea, paralysis of radiating muscles, cataract, granulated lids, and shrinking of optic nerve.

9. *Granulated Lids.* 1. Cause — enlarged blood vessels due to strain and bad vision.
   2. Inflammation — conjunctiva over large, hardened blood vessels wears through, causing ulcers.
   3. Treatment — keep down inflammation, protect against light, and call a physician.

10. *Motion and Sight.* 1. Reading in moving car — overworks muscles and injures sight.
   2. Reading while lying down — strains muscles.

CHAPTER XLV

HYGIENE OF THE EYE (*continued*)

1. **Astigmatism.** — This trouble is caused by an irregular shape of the eyeball, or an irregular cornea. If the perpendicular and horizontal diameters of the eyeball differ very much, the eye is out of shape, and the focus falls at the wrong place in the retina, or at some point before or behind the retina, and vision is blurred. If the cornea is not curved uniformly, the object may seem distinct in some parts and blurred in others. In both of these forms, the muscles are strained to change the focus, and usually severe headache follows. The defects are corrected with glasses.

2. **Cataract.** — Cataract is the clouding of the crystalline lens, so that vision is indistinct or lost. A surgical operation usually cures it. The lens is taken out, and if the remaining humors do not become more dense, so as to restore sight, it can be restored by the use of glasses with convex lenses.

3. **Nearsightedness.** — Nearsightedness is caused by a defect in the lens; the refractive power is too great,

and the focus falls in front of the retina. The eye has a small range, and can see things only when they are very close to it. It is overcome by concave glasses.

4. **Farsightedness.** — In farsightedness, the refractive power of the lens is too small, and the image would fall behind the retina. Such eyes can distinguish objects only at great distance. This is corrected by use of convex glasses. Later in life a person who had far sight may need two pairs of glasses, one for near and one for far sight. When the eyes have adjusted themselves to the glasses for near sight, they cannot see distant objects.

5. **Oldsightedness.** — As age advances, the eye loses its power of adjustment; very little adjustment is required for distant objects, but much is needed for objects near by; for this reason the eye cannot adjust itself to objects close at hand. It is a functional defect, and is due to some loss of the power of contraction in the muscles of the lens, and perhaps the loss of elasticity of the lens itself. It is different from farsightedness. It does not occur until about the age of forty-five, and is corrected by convex glasses.

6. **Color Blindness.** — Color blindness is the defect of the eye which causes us to mistake one color for another. The usual form is to be unable to recognize red, taking it to be green or some other color. Some people cannot distinguish some of the other colors, as blue and brown, or blue and green; others are unable to distinguish different shades of the same color except when they are seen together. Defects of this kind, in some form, are very common.

7. **Cross Eyes.** — "Cross eyes," "wall eyes," or other oblique eyes, is a defect in the muscles of the eye or their

nerves. It usually exists from birth, but may be caused by illness or accident. When caused by illness, it is usually temporary. The muscles of the eye are in pairs, and one muscle may be too strong for its mate, and pull the eye out of line. Or one muscle may be too short for its mate, or one may become paralyzed, when its mate will pull the eye in the other direction. Sometimes these disorders are due to defective vision and strain, and may be corrected by glasses; but usually a surgical operation is required; a muscle too strong is weakened by being partly cut, and one too short is cut and attached at a new point, thus equalizing it and its mate.

8. **Moving Motes.** — It is not uncommon to see what seem to be specks or strings floating about through the air. These are not real, and are caused by small dark particles in the vitreous humor within the eye, or are due to the unequal spreading of tears over the sight.

9. **The Spots.** — There are two important spots in the eye, (1) the yellow spot, and (2) the blind spot. The yellow spot is the only point where vision is perfect; it is in the exact center of the retina behind. The yellow spot is a slight elevation with a depression in it, and the cones about it are smaller. The blind spot is where the optic nerve enters the eye; it is near the yellow spot, toward the nose; when the focus falls on this spot, the eye cannot make an image; the spot is blind, as the following experiment will show:

Close the right eye, look at the right spot with the left *eye, and* move the book to or from the face until the

right spot cannot be seen; the spot disappears because its image falls on the blind spot of the open eye. Then try it with the right eye and left spot. An image cannot fall on the blind spots of both eyes at the same time.

10. Irradiation. — This is an interesting illusion of color. Persons dressed in white look larger than when dressed in black; a white spot looks larger, and a black spot smaller than they really are, when each has a background of the opposite color. The strong light from white seems to enlarge the image upon the retina. A similar illusion is caused by altitude; an object occupying a point above one always looks larger, and when occupying a point below always seems smaller. A house on a hill looks much larger to a person in the valley, and smaller when their positions are exchanged.

11. Alcohol and the Eye. — Alcohol, because of its effect upon the nervous and circulatory systems, is injurious to the eye. It enlarges the capillaries of the lids and inflames the eye; it weakens the optic nerve and makes the vision dim.

12. Tobacco and the Eye. — Tobacco weakens the optic nerve, and tends to produce a dim vision through its poison. Tobacco smoke is injurious to the eyes, especially the smoke of cigarettes.

13. Hygienic Suggestions. — The following suggestions will aid in keeping the eyes well, and vision clear: —

1. Bathe the eyes in cold water, or salt water, to soothe and reduce inflammation. Do not put any medicine in the eyes without the advice of a physician.

2. Light should not fall on the eyes, but upon the work in reading or in needlework. Light should come over the shoulder or from behind.

3. The eyes must have abundant rest. Constant use on objects at same distance makes eyes weak.

4. On recovering from most diseases, the eyes are very weak. This is especially true of eruptive diseases. It is easy then to injure them for life.

5. Avoid everything that gives the eyes strain or pain; dust, smoke, and some gases are very hard on the eyes.

6. Blowing the nose forcibly will sometimes dislodge a foreign body in the eye. Close opposite nostril, and blow the one next to the eye in trouble.

7. Never wear glasses that were not made to order. Only a competent oculist can fit them.

8. Every one who works by an artificial light should have only the best. It should be bright, steady, and fall upon the work. There is no economy in poor lights; they have ruined many an eye. Avoid a dazzling, flickering, or tinted light for work.

9. Every one should choose a competent eye specialist, and consult him when any trouble arises.

10. It is easier to prevent than cure; it is well to consult an oculist regularly, just as you consult a dentist, even when it is not certainly known that there is trouble.

OUTLINE SUMMARY

1. *Astigmatism*. 1. Definition — imperfect focusing.
   2. Cause — irregular shape of eyeball or cornea.
   3. Cure — glasses.
2. *Cataract*. 1. Definition — clouding of the crystalline lens.
   2. Cure — surgical operation. Make statement.
3. *Nearsightedness*. 1. Cause — defect in lens; focus falls in front of retina.
   2. Cure — glasses.
4. *Farsightedness*. 1. Cause — defect in lens; image falls behind the retina.
   2. Cure — glasses.
5. *Oldsightedness*. 1. Cause — as age advances, eye loses power of adjustment.
   2. Cure — convex glasses.

6. *Color Blindness.* 1. Definition — always taking one color for another.
 2. Treatment — very little can be done for it.
7. *Cross Eyes.* 1. Definition — a defect due to the muscles or their nerves, to illness, or defective vision. Result in double vision.
 2. Remedy — sometimes glasses, but usually a surgical operation.
8. *Moving Motes.* 1. Definition — apparent specks and strings moving in the air.
 2. Cause — small dark particles in the vitreous humor, or tears.
9. *The Spots.* 1. Blind spot — where the optic nerve enters.
 2. Yellow spot — point of perfect vision, in exact center of retina behind.
10. *Irradiation.* 1. Definition — an illusion of color. Make statement.
 2. Cause — due to properties of light. White makes a larger image on the retina.
11. *Alcohol and the Eye.* 1. Effects — enlarges capillaries, inflames, injures optic nerve.
 2. Treatment — remove cause, and treat each injury.
12. *Tobacco and the Eye.* 1. Effects — injures optic nerve, and tends to produce dim vision. Smoke of cigarette is injurious.
 2. Treatment — remove cause if possible, and treat the several injuries.
13. *Hygienic Suggestions.* 1. Perfect vision — but few have it.
 2. Rules. Make statement.

CHAPTER XLVI

THE EAR

1. Parts. — The ear is the organ of the sensation of hearing, and is one of the most delicate organs in the body. It is composed of three parts: (1) the external ear, (2) the middle ear, and (3) the internal ear.

2. The External Ear. — The visible portion of the ear is called the external ear, and is composed of two parts: (1) the pinna, and (2) the auditory canal.

The pinna is the large, outer portion; the soft portion below the opening is called the lobule.

The auditory canal is the tube connecting the pinna

and the middle ear. The walls of the outer portion of the canal are cartilage; the inner portion is in the temporal bone, and the lining is a membrane which is a continuation of the skin of the external ear. The outer portion of the canal contains some hairs and oil glands, and the inner portion contains the glands that secrete the ear wax. The chief use of the external ear is to collect more of the sound waves than the canal alone can catch, and thus aid hearing.

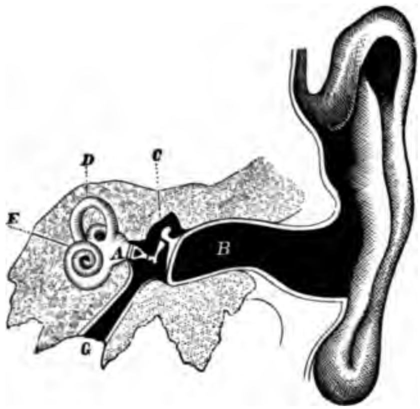


FIG. 64. — The ear.

A, vestibule; *B*, auditory canal: *C*, hammer, anvil, and stirrup; *D*, semicircular canals; *E*, Cochlea; *G*, Eustachian tube.

Sound is the sensation made by waves of air; they are carried to the nerve of hearing and reported to the brain; the kind of wave determines the pitch and loudness of the sound.

3. The Middle Ear. — Going inward, the next division of the ear is called the middle ear, or tympanum; it is situated in the petrous portion of the temporal bone, is irregular in shape, and lined with mucous membrane. The middle ear is composed of three parts: (1) the ear drum, (2) cavity or chamber, and (3) bones.

The ear drum is a thin membrane, oval in shape, stretched tightly across the auditory canal, and separates the external ear from the middle ear. It vibrates easily, and responds to every sound wave, unless diseased. It receives the sound wave from the external ear, and sends it along a chain of small bones to the internal ear. The

middle ear is connected with the pharynx by the Eustachian tube, which, by admitting the air to the middle ear, equalizes the pressure on the ear drum ; otherwise, the pressure of the air from the outside would injure it, or even break in the ear drum. But when the drum has air of equal density on both sides, it does not feel the weight of the air on the outside, and is enabled to vibrate. The tube, as an outlet, relieves some of the pressure when a loud sound wave strikes the drum, and serves as a drain from the middle ear.

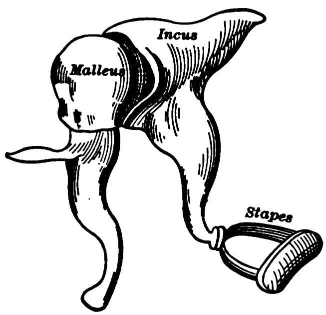


FIG. 65. — The bones of the ear.

There are three bones of the middle ear, all connected and extending along the cavity from the drum to the internal ear. They carry the vibration of the sound wave from the drum to the internal ear, and are so arranged as to increase the force of the wave. Their names are ***malleus***, ***incus***, and ***stapes***, sometimes called hammer, anvil, and stirrup, from a supposed resemblance to these objects.

The middle ear is the seat of most ear troubles, earaches, and a very painful, dangerous disease called middle ear trouble.

4. The Internal Ear. — The internal ear is composed of two parts: (1) the cavity, and (2) floating sea of fluid. The cavity is an irregular bony opening of three parts called the ***vestibule***, the ***semicircular canals***, and the ***cochlea***.

The vestibule, the outer chamber of the internal ear, is about an eighth of an inch in diameter, lined with a serous membrane, and filled with a clear fluid (perilymph). The vestibule has numerous small openings leading to the

middle ear, the cochlea, and semicircular canals, and other openings for the entrance of the branches of the auditory nerve.

The semicircular canals are three loop-shaped tubes, branching off from the vestibule, filled with a fluid, and supplied with nerves. Two of them are in a perpendicular position, and one horizontal. Their use is not very well understood, but besides aiding in hearing, they are supposed to aid the body in balancing itself; when they are diseased, one is not able to keep a balanced, upright position.

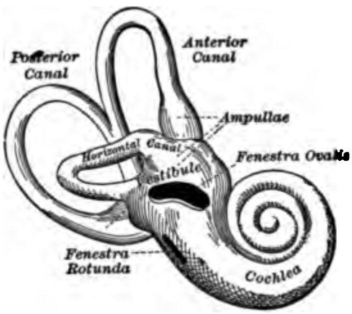


FIG. 66.—The bony labyrinth of the right ear.

The cochlea is a winding cavity or canal, and looks something like a snail shell. It has an axis, and a spiral portion which coils about the axis. To the cochlea is given the most important work of hearing; all parts of the ear thus far merely carry the sound wave, but the cochlea, with its delicate nerve ends, is to distinguish between the different sounds, and transmit the impulses to the brain. By the cochlea, too, the direction of sound is determined.

The auditory nerve sends a branch to the cochlea and a branch to the vestibule; the former is the nerve of hearing; the latter is the nerve for noise or confused sound, and for balancing the body.

5. The Process of Hearing. — Some object is set in motion which makes a wave of air; this wave enters the external ear, and strikes the drum; it is carried by the

bones of the middle ear to the internal ear, where it sets a fluid in motion; this motion reaches the cochlea, and the semicircular canals, setting in motion their fluids. The wave is caught up by the branches of the auditory nerve, and the impulse is carried to the brain.

If the sound wave is merely that of a loud, coarse noise, the nerves of the vestibule take it; but if it is composed of regular wave sounds, the nerves of the cochlea take it. The vibrations of musical sounds are regular, while those of noise are irregular. Loud sounds are made when the wave is large. Pitch is due to rapidity of the wave. The ear cannot catch the waves if they are fewer than about sixteen per second, or more than 40,000 per second.

6. Illusions of Sounds. — Loud, high-pitched sounds appear far away, while delicate sounds of low pitch appear to be very near; both impressions are usually wrong, and sometimes are exactly the reverse of what they seem. The nerves of hearing may be irritated by many things that will falsely excite the sensation of hearing, as drugs like quinine, a blow on the head, wax in the ear, too much blood in the internal ear, air too dense or too rare in the middle ear, singing in the ears when taking cold, and the tingling sounds that sometimes accompany middle ear trouble. A slight irritation of the auditory nerve when asleep or drunk will recall images very vividly and make them seem real.

7. Ear Wax. — Ear wax is secreted by the *ceruminous glands* of the outer ear; its purpose is to keep out dust, foreign bodies, and insects. It is sticky and bitter. All wax that appears at the opening should be removed with a soft, wet cloth, but all the wax should not be removed

from the canal, as the ear needs its service. The ear should never be picked with hard, metallic instruments like pins or small nails.

OUTLINE SUMMARY

1. *Parts of the Ear.* 1. Names — external ear, middle ear, and internal ear.
   2. Use — constitute the organ of hearing.

2. *The External Ear.* 1. Parts — two: the pinna, and auditory canal.
   2. The pinna — the outer, visible portion of the ear.
   3. The auditory canal — connects the pinna and middle ear.
   4. Use — to catch and convey sound waves.

3. *The Middle Ear.* 1. Location — in petrous portion of temporal bone.
   2. Parts — three: ear drum, cavity, or chamber, and bones.
   3. The drum — thin, oval-shaped, and stretched tightly across the canal; receives sound waves.
   4. Connection with pharynx — by Eustachian tube, which supplies air to equalize pressure.
   5. Bones — three, called malleus, incus, and stapes; they convey and increase the sound wave.
   6. Disease — seat of earache, and middle ear trouble.

4. *The Internal Ear.* 1. Parts — two: cavity and floating fluid.
   2. Cavity — an irregular, bony opening of three parts: the vestibule, semicircular canals, and cochlea.
   3. Vestibule — tube with a serous membrane, filled with fluid.
   4. Semicircular canals — three loop-shaped tubes branching off from the vestibule; they are filled with a fluid, aid in hearing, and in maintaining the balance of the body.
   5. Cochlea — a winding cavity with an axis and spiral portion.
   6. Special function of cochlea — to distinguish sound.
   7. Nerves — the auditory nerve sends a branch to the cochlea, and one to the vestibule.

5. *The Process of Hearing.* 1. Steps. Make statement.
   2. Pitch — due to rapidity of vibrations.
   3. Limits — not fewer than sixteen vibrations, nor more than 40,000 per second.

6. *Illusions of Sound.* 1. Distance — the illusion of *loud* and *delicate* sound.
   2. Irritations — many. Make statement.

7. *Ear Wax.* 1. Secreted — ceruminous glands.
   2. Properties — sticky and bitter.
   3. Use — keeps out foreign bodies.

CHAPTER XLVII

HYGIENE OF THE EAR

1. **Loud Sounds.** — Very loud sounds of a violent, explosive nature may rupture the drum and cause total deafness. The strain upon the drum may be overcome by keeping the mouth open when such a noise is expected, as this will aid in equalizing the pressure on the drum; standing on one foot, or keeping the body relaxed so it may yield to the strong air wave, will serve to lessen the pressure on the ear drum.

2. **Objects in Ear.** — Children frequently get beans, cherry stones, and other small objects in the ear; these objects may enter the ear easily, but be hard to remove; the canal is larger near the drum than at the opening, and an object may remain in the ear some time without doing any damage. The head should be turned with the affected ear downward, to give the object an opportunity to fall out. A gentle shaking or jarring of the head may cause it to drop out; if this does not give relief, fill the canal with some warm soapsuds by use of an ear syringe; this usually forces out the object. Do not pry or gouge with hard instruments, as this may destroy the hearing. If it cannot be removed by the means suggested, send for a physician.

3. **Insects.** — Notwithstanding the wax and hair of the canal, many insects get into the ear. They cannot go farther than the drum, but they may bite, poison, or burrow, or they may almost distract one with the noise of their movements. Pour some sweet oil or any ordinary oil in the ear to kill the insect; almost any oil will do this, and

not in any way injure the ear. Then wash out the insect with warm soapsuds. Do not try to kill the insect with pressure, or with hot or cold water. In injecting a fluid, always use an ear syringe.

4. Atmospheric Pressure. — The weight of the air at the sea level is about fifteen pounds to the square inch; in climbing a mountain, we find that the air becomes lighter; if the mouth be kept closed, the air in the middle ear will soon be more dense than outside air, and will bulge the ear drum outward. In such cases one should frequently swallow to send some fresh air up the Eustachian tube, and equalize the pressure by having air of the same density on both sides of the drum. The same should be done in descending a mountain.

5. Deafness. — Closing the Eustachian tube will destroy the equal pressure upon the ear drum; the outside air will press the drum in and destroy its vibrating power; this will cause temporary, partial, or even permanent deafness. When the tube is closed, the ear feels full, and sings and roars. Adenoid growths and enlarged tonsils will close up the tube and produce deafness.

When deafness is caused by closing the Eustachian tube, the tube should be opened and air let in several times a day. It may be done by holding the nose, closing the mouth, blowing hard, and swallowing at the exact time of blowing.

In case of sore throat, the inflammation may ascend the tube to the ear, causing mucus and waste matter to collect and press upon the drum, and producing a severe earache. The natural outlet for this waste is the Eustachian tube; if the tube does not open, the matter gathered in the middle ear may break the drum, and run out. The drum *will usually* heal. Sometimes a physician has to puncture

the drum to let this matter out. Excepting injuries of the drum, nearly all deafness can be traced to throat and nose troubles.

6. **A Running Ear.** — A running ear is always dangerous. The matter should be removed with warm, sterile water as fast as it comes out. While the ear runs, the drum is open, and there is danger of an inflammation that may eat into the brain, which usually produces death. A running ear should be treated by a physician, and no time be lost.

7. **Injuries of the Ear.** — In games of ball, boxing, and snowball, there is danger of injury to the drum; a stroke of the ball may compress the air and force it upon the drum. Permanent deafness is sometimes caused by being struck on the ear with a ball.

8. **Odors and Hearing.** — Strong, pungent odors weaken the nerves of the nose; smelling salts, it is said, will injure hearing by affecting the nerves of the nose, and through them injuring the ear. Any odor that acts on the secretions of the nose and pharynx may indirectly cause ear trouble.

9. **Alcohol and Tobacco.** — Both alcohol and tobacco may produce inflammation of the throat and Eustachian tubes; this inflammation sometimes extends to the ear and impairs the hearing.

OUTLINE SUMMARY

1. *Loud Sounds.* 1. Danger — may rupture drum.
   2. How counteract — open mouth, stand on one foot, or relax body.
2. *Objects in Ear.* 1. What objects — beans, cherry stones, and other hard objects.
   2. Remedy. Make statement.

3. *Insects.* 1. What insects. Make statement.
   2. Remedies — pour in sweet oil, then wash out ear with soap-suds. Do not pour hot or cold water in ear, nor try to kill insect with pressure.
4. *Atmospheric Pressure.* 1. Density — in climbing or descending a mountain, we find that density changes.
   2. Equalization — air in middle ear and external ear must be of same density; swallowing.
5. *Deafness.* 1. Causes — closing of Eustachian tube; throat and nose troubles, and injury to drum or nerves.
   2. Remedies — clear tube, cleanse ear, and remove cause. See physician.
6. *A Running Ear.* 1. Danger — always dangerous.
   2. Treatment — remove all inflammation and running matter. See a physician.
7. *Injuries of the Ear.* 1. Games — ball, snowball, and boxing may rupture the drum.
   2. Care — a delicate organ, and should be protected in games.
8. *Odors and Hearing.* 1. Danger — strong, pungent odors weaken the nerves in the nose and sometimes reach the hearing.
   2. Secretions — any odor that increases the secretions of nose may injure hearing.
9. *Alcohol and Tobacco.* 1. Effect on throat — inflame the throat and Eustachian tubes.
   2. Danger — any throat trouble is likely to injure hearing.

CHAPTER XLVIII

THE NOSE

1. **The Organ of Smell.** — The nose, with its spreading nerve ends, and its extensive mucous membrane, is the organ of smell. The sense of smell is a modification of the sense of touch.

2. **The Nose.** — The nose is composed of two similar cavities, separated by a partition composed of the vomer, some cartilage, and the nasal linings. Each cavity is composed of two parts, called the anterior and posterior chambers; the anterior chamber opens upon the face, and the posterior chamber opens into the pharynx. All of the

interior of the nose is lined with mucous membrane, a portion of which is supplied with brown pigment cells and ciliated cells. The outer walls of the nose are formed of the nasal and lachrymal bones; beneath these are the cavities called sinuses. A few hairs are found at the external opening of the nose; they serve to arrest dust and other foreign objects breathed into the lungs.

3. The Olfactory Nerve. — The first cranial nerve is the olfactory; its only function is the sensation of smell. It ends in the olfactory ganglion on the ethnoid bone, from which it branches into many threads that spread out like a spider web upon the surface of the chambers of the nose.

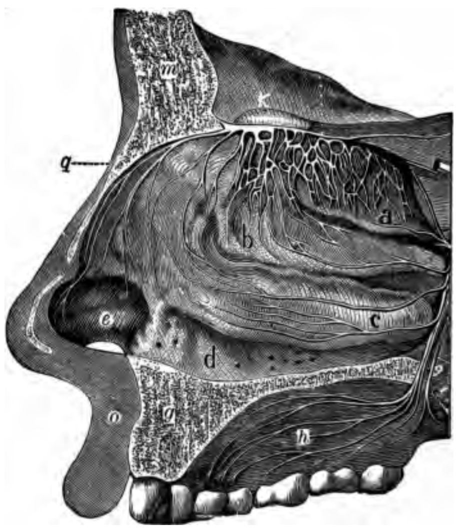


FIG. 67.

a, b, c, d, interior of the nose, which is lined by a mucous membrane; *n*, the nose; *e*, the wing of the nose; *q*, the nose bones; *o*, the upper lip; *g*, section of the upper jawbone; *h*, the upper part of the mouth, or hard palate; *m*, frontal bone of the skull; *k*, the ganglion or bulb of the olfactory nerve in the skull, from which are seen the branches of the nerve passing in all directions.

4. The Sensation of Smell. — Every odorous substance gives off very small particles, which float about in the air; they enter the nose and stimulate the nerve ends. The impulse is carried to the brain, and produces the sensation of smell. Particles to be smelled must enter the nose in gaseous form; the solid or liquid

body from which they came, if put in the nose and against the nerves, would not produce a sensation of smell at all.

5. Use of Smell. — The sense of smell enables us to enjoy agreeable flavors in foods and drinks, and the sweet perfumes of flowers and chemicals; it also warns us against the dangers of foul air, injurious gases, and decaying matter. Air with a bad odor, like water with a bad odor, is unfit for use.

6. Impaired Function. — The sense of smell, when at its best, is very acute. Catarrh, with its floating mucus, and colds, with their congestion, are among the more common conditions that destroy the acuteness of this sense. Gases like ammonia, and the fumes of the laboratory, the soap factory, and the tanyard are hurtful. Almost any unpleasant odor will, if continued long enough, injure the nerves of smell.

7. Clean Nose and Mouth. — The nose and mouth being the seat of two of the most delicate senses in the whole body, and what they receive and pass on into the body having more to do with health than anything else, it is of first importance that they be kept perfectly clean, and that the secretions of each be kept out of the other; also that inflammation in either be kept out of the other, and out of the Eustachian tube. Nothing but air should ever go from the pharynx to the ear. No discharge from the nose should ever be swallowed. The healthy or unhealthy condition of these two organs will affect the health of the whole body. That the sense of smell may not be impaired, the nose should be kept clean and moist. If dry, or coated with anything, the sense is partly lost.

8. Hygienic Suggestions. — The following suggestions will aid in keeping the nose in a healthy condition:

1. Keep the nose clean in both chambers; if the mucus coagulates, and becomes very hard, soften it with warm water, and remove it with a soft handkerchief.

2. Do not clean nose with any hard substance, lest the delicate membrane be injured.

3. Do not pick the nose with the finger; the finger nails may cut the mucous membrane or carry filth or disease germs to delicate surfaces.

4. Do not pull out the hairs at the opening of the nose, as they may tear the flesh and make a little wound that will ulcerate. If they are too long, clip them with a pair of shears. The hairs are needed there.

5. Tobacco smoke and snuff are very irritating to the nerves of smell. If continued, they weaken and blunt the sense.

6. Alcohol weakens the nerves of smell. Persons who habitually drink find the sense impaired in time, and sometimes lose it entirely.

OUTLINE SUMMARY

1. *Organ of Smell.* 1. Nose — the organ of smell.
   2. Relation to touch — modification of sense of touch.
2. *The Nose.* 1. The cavities — two.
   2. Chambers — anterior and posterior.
   3. Membrane — mucous.
   4. Outer walls — formed of nasal and lachrymal bones.
   5. Sinuses — cavities beneath bones of the walls.
   6. Hairs — at outer extremity, to arrest dust and other foreign bodies.
   7. Nerves — wide-spreading and abundant.
3. *Olfactory Nerve.* 1. Function — to transmit impulses of smell.
   2. Anatomy — rises with three roots that unite, and ends in the olfactory ganglion, from which its threads go out to the nose.
4. *Sensation of Smell.* 1. Manner — small particles of the thing smelled must enter the nose.
   2. Odor of solids and liquids — have none if they do not give off minute particles that can enter the nose.
5. *Use of Smell.* 1. Enjoyment — enables one to enjoy agreeable flavors and sweet perfumes.

2. Warning — warns against bad odors, foul air, and infected substances.

6. *Impaired Smell.* 1. Causes — catarrh, colds, gases, and bad odors.
2. Results — loss of pleasure and protection.

7. *A Clean Nose and Mouth.* 1. Delicate senses — two of the most delicate senses of the body. They work well only when they are clean and healthy.
2. Diseased refuse — no refuse of either should ever enter the other.

8. *Hygienic Suggestions.* 1. Rules. Make statement.
2. Disease — see a physician.

CHAPTER XLIX

TASTE

FIG. 68. — Tongue, showing papillæ of taste.

a, circumvallate papillæ; *b*, papillæ.

1. Organs. — The tongue is the chief organ of taste, and is aided by the soft palate, the uvula, and the back part of the mouth, all of these organs having some of the nerve ends of taste.

2. The Tongue. — The tongue is a muscular organ of varying size, made up of several sets of muscular fibers, and covered with mucous membrane. It is connected with the hyoid bone at its base by some of its muscles, while its tip and a portion of its edges are free. On the upper surface of the tongue there are numerous papillæ, similar to the pa-

pillæ of the skin. The papillæ contain the ends of the nerves of taste.

3. Nerves of Taste. — For the sensation of taste, branches of two cranial nerves are sent to the tongue. In the sides of many of the papillæ, especially the larger papillæ, there are some flask-shaped bodies called *taste buds*, or *gustatory bulbs;* they are complex, but well supplied with nerves, which are the chief nerves of taste.

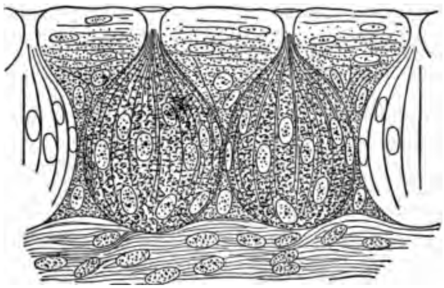


FIG. 69. — Taste buds.

4. Process of Taste. — In order to be tasted, substances must be in liquid form; solids cannot be tasted except as they are converted into liquid. After foods are thoroughly masticated and converted into liquid by the saliva, the particles affect the ends of the nerves of taste, the impulse is transmitted to the brain, and the sensation of taste produced.

5. Areas of Taste. — While it is likely that almost all the area of taste takes part in all acts of taste, it is true that certain areas or parts of the surface of the tongue are highly specialized; that is, some things can be better tasted at one part of the tongue, and other things at other parts. The principal tastes are sweet, sour, salt, and bitter, or some of their combinations. Sweet things produce the clearest sensation of taste on the front part of the tongue, and bitter things on the back part of the tongue. Sour things are best tasted on the edges, or front of tongue, and salty things by the back part of the tongue.

6. Quality of Taste.—By quality of taste is meant the accuracy of the sensation. A taste of good quality must make true sensations of the things tasted. Cultivation has much to do with this. Then the sense of smell must be good, as some foods of high flavor are appreciated by both the taste and smell. A trained taste enables one to not only distinguish good and bad food, but the different qualities of foods. A good taste is of first importance in good digestion, as good flavors excite the flow of saliva. Taste may be trained so a food once disagreeable may become agreeable; this is especially true in liquors. A good cook depends much upon a trained taste.

7. Use of Taste.—Taste, then, aids in selecting foods that are most pleasing and best, and discarding those that are unwholesome; it enables us to select those that will digest easily. It enables experts to determine the quality and value of tea, coffee, liquors, tobacco, and to some extent of sugars and sirups. Taste may become so blunt by use of alcohol, tobacco, and highly seasoned foods as to distinguish articles of diet only in a coarse way, and to be satisfied with only very highly seasoned foods; the delicate taste for the natural flavors of things may be entirely lost.

8. Hygienic Suggestions.—The following suggestions will aid in cultivating the taste and keeping it healthy:

1. Very hot foods and highly seasoned foods should not be used.
2. Alcohol and tobacco irritate the nerves and blunt the taste.
3. Eat very slowly things that are hard to dissolve.
4. Do not acquire the habit of hasty eating, as it injures the taste.

5. Do not use peppers and spices to excess; they injure the taste and render us unable to know when food is wholesome.

6. As far as possible, let the sense of smell aid taste. If the nose is stopped up with a cold, some things taste very different, an onion, for instance.

7. When the digestive organs are deranged, the tongue is coated; the coat is composed of waste epithelial cells, mucus, and bacteria. This should be cleaned off as soon as it appears.

OUTLINE SUMMARY

1. *Organs.* 1. Tongue — chief organ, aided by the soft palate, uvula, and back part of mouth.
   2. Nerve endings — taste at last depends upon the nerve endings.

2. *The Tongue.* 1. Anatomy — muscular, with several sets of fibers and mucous membrane; connected with the hyoid bone.
   2. Papillæ — simple and compound; they contain the nerve ends of taste.

3. *Nerves of Taste.* 1. Number — branches of two cranial nerves are sent to the tongue.
   2. Taste buds — flask-shaped bodies in the large papillæ.

4. *Process of Taste.* 1. Form of food — it must be liquid to be tasted.
   2. Nerve ends — small liquid particles come in contact with the nerve ends, and the impulse is carried to the brain.

5. *Areas of Taste.* 1. Specialized areas — some things are more easily tasted in one part of the tongue than in other parts.
   2. Principal tastes — salt, bitter, sour, and sweet.
   3. Area of each taste. Make statement.

6. *Quality of Taste.* 1. Definition — accuracy of the taste sensation.
   2. Cultivation — accurate taste depends much upon cultivation.
   3. Importance — of first importance in digestion.

7. *Use of Taste.* 1. For judging foods — it enables one to select and discard foods; also to test quality of coffee, tea, liquors, and other things.
   2. Impaired taste — from use of alcohol, tobacco, and spice.

8. *Hygienic Suggestions.* 1. Rules. Make a statement.
   2. Impaired function — try to correct at first appearance.

CHAPTER L

TOUCH

1. **Organs.** — The organs of sensation, or touch, are the skin, including its papillæ and nerve endings, the sensory and motor nerves, and the nerve centers to which the nerves of touch report. In a narrow sense, the skin and its modifications and the mucous membrane constitute the organs of touch.

2. **Kinds of Sensations.** — For convenience, sensations are divided into (1) common, and (2) special. Common sensations are such feelings as hunger, thirst, fatigue, and sickness. The special sensations are sight, hearing, taste, smell, and touch, including the modified forms, as the muscular sense, temperature, and weight; in fact, taste and smell also are modified forms of the sense of touch, or feeling.

3. **The Muscular Sense.** — By pressure against an object, or by lifting it, one is enabled to judge its weight. This is called the muscular sense, or sense of weight. It is not a sixth sense, coördinate with sight or hearing, as some have thought, but only a specialized form of touch; unlike sight or hearing, it has no particular brain centers of its own, but its impulses go to the same centers as all other sensations of touch. It is a valuable sense, and may be trained to great accuracy.

4. **Touch.** — The sense of touch makes known the conditions of an object, as hard or soft, liquid, semisolid, or solid; it gives a sensation of shape, as round, square, and angular; also of proportion and texture, as in cloth.

This sense varies in degree in different parts of the body, depending upon how numerous the end nerves, and how near the surface. The eye, lining of the nose, and tip of the tongue are very sensitive. The nerves of feeling by which we distinguish form, proportion, smoothness, dampness, and temperature are in the palms of the hands and inside the fingers. The touch of the finger tips is very delicate, and may be trained to great accuracy.

5. **Temperature.** — There are no "heat centers" anywhere in the nervous system; the temperature sense is a modification of the sense of touch, the sensation being reported by nerve ends a little more pointed than ordinary nerve ends, and close together. It reveals to us the temperature of an object. The amount of heat in the body affects the accuracy of this sense. Also the character of the object touched, as when a piece of steel is held in one hand and a piece of wood of same temperature in the other, the steel will appear different in temperature from the wood. This sense can be trained to recognize as little as one fourth of a degree of temperature.

6. **Vital Feelings.** — The sensations of sickness, languor, fatigue, hunger, and thirst are known as the vital feelings, since any of them, if continued far enough, will destroy life. They are distinct sensations, and are feelings of the whole body; they are sometimes called "common sensations." But most of them make themselves known through some special organ; hunger is felt in the stomach, thirst in the mouth, sickness usually in the organ most affected, and fatigue in the organ or system most exhausted. Fatigue and sickness also may be so general as to affect almost every tissue in the body.

7. **General Sensations.** — The general, or common sensations, such as hunger, thirst, fatigue, temperature, weight,

and some others of still more general nature, are made, or may be made, by stimulating the nerves of common sensations which are found in all parts of the body; but special sensations are made by exciting special, localized nerves. All sensations are either pleasant or painful.

8. **Special Sensations.** — As already stated, special sensations are started by some special, localized nerve end organs, as sight, hearing, and taste; touch, while general, is also special, and its organ is composed of the nerve extremities of the palms and inner surface of the fingers, just as the nerve extremities of taste are found chiefly upon the upper surface of the tongue. The nerve ends of special touch are called "tactile corpuscles," and are as highly specialized as the nerve ends in the "gustatory bulbs" of the tongue. They are perhaps capable of more delicate cultivation.

9. **Hygienic Suggestions.** — The following suggestions will aid in preserving the natural sense of touch and training it:—

1. Alcohol weakens the nerves of touch and may produce a neuritis, or inflammation of the nerves.
2. Sensory nerves may be permanently impaired by excessive heat or cold; burning or freezing a hand may destroy its tactile corpuscles, and forever destroy the sense of special touch.
3. Great shock may impair a sensory nerve or its end organs.
4. Sciatica, a disease of the main nerve of the leg, may cause loss of tactile sensation of that member, or a part of it. Sciatica should not be neglected.
5. Injuries or disease in either the spinal cord or the brain may result in loss of the sense of touch in areas supplied by the nerves affected.

6. Certain areas of the body may become too sensitive, or too dull, through the influence of the mind upon the nerves. Sensation may amount to pain, or be entirely lost from this cause.

OUTLINE SUMMARY

1. *Organs.* 1. The skin — the skin and other coverings, as the mucous and serous membranes, are the chief organs of touch.
   2. Sensory and motor nerves — to carry and return impulses.
   3. Nerve centers — to receive and convert an impulse.
2. *Kinds of Sensations.* 1. Common — hunger, thirst, fatigue, and feelings of sickness.
   2. Special —sight, hearing, taste, smell, and touch, with its modified forms.
3. *The Muscular Sense.* 1. Definition — a modified form of touch, by which we are conscious of weight.
   2. Specialization — a specialized form of touch; it has no center of its own.
4. *Touch.* 1. Function — to make known whether an object is hard, liquid, or solid; also shape, proportion, texture, and place.
   2. Degree — varies, depending upon how numerous the nerves, how near the surface, and how well trained.
5. *Temperature.* 1. Definition — a modified form of touch; specialized to report temperature.
   2. Nerve ends — a little more pointed and closer together than usual.
   3. Training of this sense —can be trained to great accuracy; it is modified somewhat by the amount of heat in the body and the nature of the object.
6. *Vital Feelings.* 1. Definition — feelings that pertain to life, as hunger, thirst, and sickness.
   2. Organs—the organs of general sensation, but reported usually by some special organ. Give examples.
7. *General Sensations.* 1. Definition — general sensations made by stimulating the nerves of common sensation.
   2. Contrast — special sensations by special, localized nerves. Give examples. Make statement.
8. *Special Sensations.* 1. How made — started by stimulating some special or localized end organ, as sight, hearing, and taste.
   2. Tactile corpuscles—nerve ends of special touch.
9. *Hygienic Suggestions.* 1. Rules. Make a full statement.
   2. Loss of sensation — any loss should have immediate attention.

CHAPTER LI

BACTERIA

1. Microscopic Life. — The microscope has revealed a world of living things too small to be seen with the unaided eye. It has shown that the spoiling of meat, the fermenting of fruit, the souring of milk, and molding of objects in damp places are caused by very small plants of only one cell, called germs. The microscope has also shown that the true causes of most contagious diseases are very minute germs.

2. Classes. — There are three principal kinds of germs, namely, (1) *yeast*, (2) *mold*, and (3) *bacteria*.

Yeast is a very tiny plant that lives upon sugar and causes *fermentation*. Heat and moisture are necessary to the growth of yeast; it multiplies at a very rapid rate; it is used in bread making, and in changing sugar to alcohol; it is one of the most useful of all the germs.

Mold is a form of plant life, and grows on such objects as wood, meat, cheese, cold foods, and even on articles of furniture in damp places. It is neither very harmful nor very useful.

Bacteria are by far the most important of all microscopic plants; they are the smallest and most numerous. There are three kinds of bacteria, each named from its shape. Rod-shaped bacteria, or those shaped something like a cucumber, are called *bacilli;* spiral-shaped bacteria are called *spirilli*, and those *round* like a coin are known as *cocci*. The names of the diseases they cause are usually prefixed to the name of the bacteria, as *tubercle bacillus*, the germ of tuberculosis, and *pneumo-coccus*, the germ of

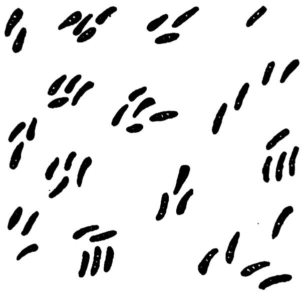


Fig. 70.—From diphtheria.

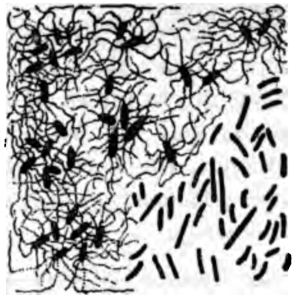


Fig. 71.—From typhoid fever.

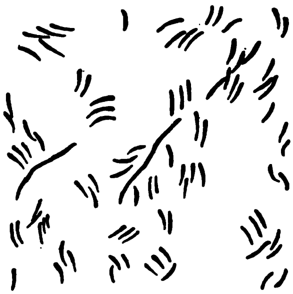


Fig. 72.—From cholera.

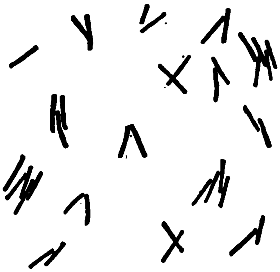


Fig. 73.—From tuberculosis.

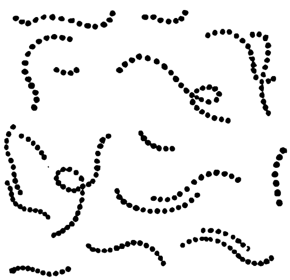


Fig. 74.—From an abscess.

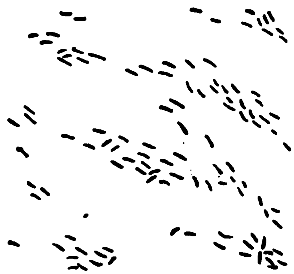


Fig. 75.—From influenza.

These figures represent the germs which cause the diseases indicated. They are very highly magnified. (From Abbott's "Bacteriology.") Each is of a different species, but all belong to the group of bacteria.

pneumonia. Bacteria are almost everywhere; they are in the air, in water, in our food, in our bodies, and in the earth; they will live and multiply wherever they can find albumin, which is their food. One bacterium can produce millions in a day, some kinds of which are very hard to destroy.

3. Size. — Bacteria are very small; to be seen at all, they require the best of microscopes. They usually vary from $\frac{1}{25000}$ to $\frac{1}{10000}$ of an inch in diameter, but a bacillus of grippe is even smaller, being about $\frac{1}{50000}$ of an inch in diameter. Thousands can inhabit a single drop of water.

4. Work of Bacteria. — Many bacteria are very useful. Decay is caused usually by evaporation, or by *bacterial action.* Bacteria usually destroy whatever they grow upon; they cause most forms of rot in vegetables, putrefaction, and the formation of poisons and bad odors; they oxidize animal and vegetable albumin in the air and in the soil, and cause it to become food for vegetables again. If it were not for bacterial action in causing the decay of dead animal and vegetable bodies, they would soon be so thick that man could not live on the earth. But some bacteria produce disease, both in man and beast. Typhoid fever, consumption, pneumonia, and many other diseases would cease to exist if the bacteria that cause them were destroyed.

5. How to destroy Bacteria. — Inside the body, bacteria are destroyed by the white blood cell, by the plasma of the blood, and by some of the poison in the blood; they are killed in the body also by the use of *antitoxin,* as in diphtheria; they are destroyed also by some of the ferments of the body, as those of the stomach, by bile from the liver, and by chemicals that may be

taken internally. Outside of the body, they may be destroyed by heat, sunlight, wind, running water, and various chemicals. The soil destroys some of them. The usual methods of destroying germs are (1) by washing, (2) by ventilation, (3) by sunlight, (4) by heat, and (5) by chemicals.

6. Bacteria of the Farm. — Many bacteria are among the farmer's best friends. The first great work of bacteria is to restore to the earth and plant life a large amount of nitrogen by the decay of dead bodies. Fertilizing is a process of giving nitrogen back to worn soils, and is done chiefly through the work of bacteria. The souring of milk, by which milk sugar is changed to lactic acid is caused by bacteria. Some bacteria are destructive, such as those causing butter to become rancid and cheese strong; among the latter class also we find the bacillus of "pear blight," causing "wilt" in cucumbers and melons, the bacillus of "brown rust" in cabbage and turnips, and the bacillus of the leaf of the egg plant and the potato.

7. Bacteria of Disease. — In man, erysipelas, diphtheria, typhoid fever, consumption, cholera, lockjaw, pneumonia, measles, scarlet fever, mumps, whooping cough, smallpox, chicken pox, the plague, leprosy, and many other diseases are caused either by germs entering the body, or by poisons made by them. In the lower animals, anthrax in sheep, cholera among fowls, cholera among hogs, glanders in horses, the swine plague, pneumonia, some fevers, tuberculosis, and the "foot and mouth" disease among cattle are contagious, and caused by bacteria. The glanders of the horse may be contracted by man, and is very fatal; the other diseases of the lower animals, except possibly tuberculosis, cannot be taken by man. Bacteria also have a part in causing "colds."

OUTLINE SUMMARY

1. *Microscopic Life.* 1. The microscope — has revealed a world of minute life.
   2. Germs — cause fermentation, souring of milk, spoiling of meats, contagious diseases.
2. *Classes.* 1. Yeast — a tiny plant that causes fermentation.
   2. Mold — a minute plant that may be seen covering wood, meat, cheese, and other articles in damp places.
   3. Bacteria — another form of tiny plant, usually called germs. They cause all forms of rot and many diseases.
3. *Size of Bacteria.* 1. Varies — usually from $\frac{1}{25000}$ to $\frac{1}{10000}$ of an inch in diameter.
   2. Bacillus of grippe — only about $\frac{1}{50000}$ of an inch in diameter.
4. *Work of Bacteria.* 1. Destruction — destroy whatever they grow upon, cause rot in vegetables, putrefaction, and poisonous odors.
   2. Subsistence — bacteria live on animal and vegetable albumin, and cause decay of animal and vegetable bodies.
   3. Diseases — they cause typhoid fever, pneumonia, consumption, and many other diseases.
5. *How to destroy Bacteria.* 1. Within the body — by plasma, poisons in the blood, antitoxin, ferments, bile, and chemicals taken internally.
   2. Outside the body — by heat, sunlight, wind, running water, and various chemicals.
   3. Disinfection — germs are destroyed by washing, ventilation, sunlight, heat, and chemicals.
6. *Bacteria of the Farm.* 1. Useful — bacteria restore to life nitrogen from decay of dead bodies; also produce fertilization.
   2. Destructive — bacteria cause rancid butter and strong cheese; they cause "pear blight" and "wilt" and decay in many vegetables.
7. *Bacteria of Disease.* 1. In man — erysipelas, diphtheria, fever, and many others.
   2. In lower animals — anthrax, glanders, swine plague, and pneumonia.

CHAPTER LII

BACTERIA (*continued*)

1. Where Found. — Bacteria live upon animal and vegetable albumin, and are likely to be found wherever they can gain access to that substance. They are abundant in the air, especially that of ill-ventilated rooms, and rooms

that are damp, dusty, and without plenty of sunlight. They are in water, especially still and stagnant water, and nearly all surface water. They may be in dust, especially the dust that comes from the basin of dried-up ponds, stables, vaults, sewers, slaughter houses, breweries, distilleries, tanyards, and soap factories. They are in some soils, especially those soils washed by water containing germs; they may be in soiled second-hand books and soiled clothing, where they may live for a long time. Some germs of dangerous diseases have been known to remain in soiled clothing for years. They are found also within the human body, in the alimentary tract, in the blood, in the lymph spaces, and sometimes in the tissues themselves. Not the germs of all diseases can be found in all these places, nor any one germ at all times, but disease germs may be found in these places sometimes. They may be found in any foods that are not well protected, and may enter the body with the food.

2. Nature prevents Disease. — Disease germs enter the body in several ways, but chiefly through the mucous membrane of the alimentary tract and the organs of respiration. We take them in our food and water, inhale them, and get them through open wounds.

Nature has provided within the body means to get rid of every germ without taking disease. We should not take it at all, perhaps, if we were always in perfect health. If the lungs are strong and the air pure, the germs of consumption cannot get a hold on the lungs; if the alimentary tract is in perfect condition, and all the ferments present in quality and quantity, no disease germs will go far without being killed. But when one is ill, or when natural resistance is below normal, the germs get through the mucous linings into the tissues, and disease begins.

Nature destroys disease germs chiefly through the action of pure water, pure air, and sunshine; disease germs cannot live in any place where these three powerful agents can do their best work. Great epidemics nearly always break out in crowded, filthy districts of cities, where it is impossible to get pure air, sunshine, and pure water. Any disease is always worse in dirty, poorly ventilated, or otherwise unsanitary rooms.

3. Prevention of Disease. — Disease is prevented by sanitary living, keeping the body in a state of perfect health, and by preventive measures like *vaccination*, *disinfection*, and *isolation*. By vaccination, smallpox is made very much milder, or prevented altogether; this disease was once very fatal, but now it is comparatively harmless, if the patient has been well vaccinated and is properly treated. Some other diseases have been handled in a similar manner. A person who cannot take a disease is said to be *immune*. By proper disinfection, the germs of disease are destroyed, and food, water, air, furniture, and clothing cleansed of germs. When a thing is cleansed of disease germs, it is described by saying it is *sterile*. This is done by certain chemical and physical agents. By isolation we mean taking the patient off to himself, and keeping him alone, where others cannot take his disease.

4. Disinfection. — Disinfection consists in destroying or dislodging disease germs. Nature does it by pure air, pure water, and sunlight, and sometimes by chemical action. Man employs these means, but disinfects chiefly by washing, heat, and chemicals. Three classes of chemicals are used: (1) *disinfectants*, that kill the germs; (2) *antiseptics*, that do not kill germs, but stop their work and overcome the poisons they make; and (3) *deo-*

dorants, which destroy or cover up bad odors, but do not have any effect on bacteria or the poisons they make.

Disinfection by heat consists in burning infected materials, in heating or boiling clothing, food, and surgical instruments, and in boiling water, milk, and other drinks. Boiling anything from fifteen to thirty minutes will kill all disease germs. One may partially disinfect his hands, clothing, and surgical instruments by washing them well with warm water and a good antiseptic soap; many of the germs will be washed away, others killed, and others overcome by this process. It is well to remember that the atmosphere, water, and houses in cities and towns contain an abundance of germs, but those of the country have few; and, ordinarily, there are none in elevated places in the country.

5. Disinfectants. — Heat has been mentioned as a disinfectant. Boiling water is best for things that can be put into it; superheated steam to about 220 degrees is good; dry heat to 220 degrees is necessary for some things. The leading chemicals used as disinfectants are *carbolic acid*, solution from 1 per cent to 5 per cent, a 2 per cent solution being sufficient for most purposes; *bichloride of mercury*, 1 part to 500–1000 parts of water; a solution of *chloride of lime*, about 4 per cent, and a solution of *corrosive sublimate.* Any druggist can prepare these, and instruct one how to use them.

To disinfect clothing, bedding, and such things, boil, or heat with dry heat to 220 degrees; to cleanse furniture, dishes, or cooking utensils, wash well in a 2 per cent solution of carbolic acid; to disinfect hands, use a 2 per cent or 5 per cent solution of carbolic acid, or bichloride of mercury, 1 to 500 parts of water; to cleanse a room, fumigate with sulphur, or formaldehyde; to sterilize

wastes from the body, use a 4 per cent solution of chloride of lime, or a 5 per cent solution of carbolic acid; to sterilize a vault, use a 5 per cent solution of carbolic acid or bichloride of mercury, 1 to 500 parts of water. Excreta from patients with fevers, vomit from patients with cholera or yellow fever, and sputa from patients with consumption, scarlet fever, diphtheria, and pneumonia, should be burned.

OUTLINE SUMMARY

1. *Where Found.* 1. In atmosphere — in nearly all air; in ill-ventilated, damp, dusty, and ill-heated rooms.
   2. In water — found in nearly all still and stagnant water, and in most surface water.
   3. Soils — bacteria are found in many soils, especially those washed by water from infected sources.
   4. Soiled clothes — disease germs are found in soiled clothing, second-hand books, toys, and paper money.
   5. In human body — germs are found in respiratory tract, alimentary tract, blood, and lymph spaces.
   6. In dust — frequently in dust that comes from the basin of dried-up ponds, stables, vaults, sewers, and other sources.
   7. In foods — disease germs are found in many foods that are not well protected.
2. *Nature prevents Disease.* 1. Entering the body — disease germs enter the body through the mucous membrane of the alimentary tract; also through open wounds.
   2. Resistance — every cell in the body resists disease.
   3. Filth — all dirt and other unsanitary conditions aid germs of disease.
3. *Prevention of Disease.* 1. Sanitary living. Make statement.
   2. Vaccination — smallpox rendered mild or prevented altogether.
   3. Disinfection — by destroying disease germs.
   4. Isolation — check disease by removing patient, keeping him to himself.
4. *Disinfection.* 1. Definition — destroying disease germs.
   2. Methods — washing, heat, and chemicals.
   3. Chemicals used — disinfectants, antiseptics, and deodorants.
5. *Disinfectants.* 1. Heat — boil clothing; heat food or surgical instruments to 220 degrees; destroys all disease germs.
   2. Chemicals — carbolic acid, bichloride of mercury, chloride of lime.
   3. Fumigation — rooms may be sterilized by the fumes of sulphur or formaldehyde.

CHAPTER LIII

THE DRUG HABIT

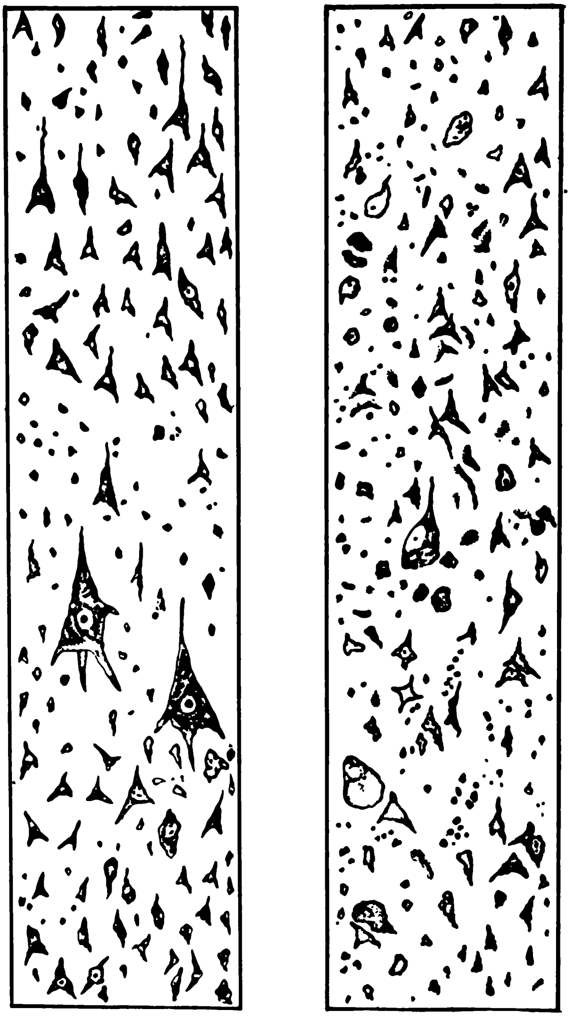
1. Formation of Habit. — Activity is the law of life; every living cell in the body must act during its life. Cells are permanently altered in shape, size, and power by their own acts. The more work they can do without exhaustion, the more nourishment they take, and the stronger they become. As their activity diminishes they shrink and die.

Cells have a tendency to repeat their acts; this is called the "law of habit"; with each repetition an act becomes easier, and if kept up long enough, becomes *automatic;* that is, the cells without aid or direction can do the act. This is the foundation of habit.

All ordinary work changes and trains one's cells until the work is easy to do. The cells grow to their work and are changed by it. Skill implies the training of cells until they will almost do a given work by themselves. The cells of a good piano player have been very much changed by training, and are very unlike the cells in the bodies of people who cannot play. This is true in all classes of work, and all forms of culture. This is what is meant by the term experience, when applied to the body.

The force of habit is very great; it is said to be second nature; indeed, it is sometimes stronger than nature itself. In some lines of action, especially in dissipation, the cells are so altered that they lose their power to act in any other way.

When cells have been trained a long time in a certain way, and lose the power to act in any other way, we say the nerves have "set." This is why old people cannot learn a new trade or a new language.



A *B*

'6. — *A*, cells from a healthy brain; **B, cells from the brain of a victim of alcohol.**

Education consists, chiefly, in making a few great habits. There are habits of mind, as well as of body. Most of such arts as music, painting, and oratory depend upon habit. When we say "practice makes perfect," we mean that it makes habit.

Habits can become so strong that they can overpower the mind, break down the moral sense, and override the will. A habit can grow until we *cannot break it*, and then we have to do what it says; we are its victim. This is particularly true of the drug habit.

2. The Drug Habit. — A drug is a chemical which increases or diminishes cell action; if it makes nerves more active, it is called a *stimulant;* if it makes nerves less active, it is called a *narcotic;* a stimulant spurs up a cell, while a narcotic soothes and quiets it. In their places drugs are good things, but out of their place they are very dangerous. As *medicine* they are useful in curing disease, which they do by causing the cells to act properly. There is some drug that can increase or retard the act of almost any cell in the body, as needed. Drugs aid the body in its fight against disease by destroying disease germs and by destroying poisons. Drugs differ from foods; foods are taken up by the cells and nourish them, while drugs merely make the cells act; drugs are what the *whip* and the *reins* are to a team, while food gives it life and power. Cells that are well fed and strong can do all the work they are intended to do, and ward off nearly every known disease; they do not need drugs to make them work; but when they are not nourished and trained, when weak or sluggish, they may become diseased, and need drugs to make them work and food to make them strong. In this way drugs cure diseases.

When a drug acts upon a cell, by the law of habit the

cell wants the drug again, and cries out for it in the form of hunger or thirst; this thirst is satisfied by repeating the act; later the thirst will reappear stronger than before, and will be satisfied only with another and larger dose; in this simple way the great drug habits are formed. So long as the cells do not demand the repetition of the use of a drug, there is no habit and no danger; habit begins with the first thirst of the cells for the drug, and that is the place to stop taking the drug. The thirst then ceases, and the cells return to normal life; but if the use of the drug is kept up, cells are altered by it, grow up to it, become "set," and cannot do without it. Finally the drug breaks down the cells and destroys them; then loss of mind in some of its parts or to some degree and paralysis in some parts of the body follow, and the end is only debauchery and death. Thus what was in its place a good thing has become the ruin of a life.

The leading drug habits are those arising from the use of coffee, alcohol, tobacco, opium, morphine, cocaine, Indian hemp, and chloral.

3. Effects of Some Common Drugs. — Each of the following drugs is capable of producing a drug habit, and many of them make such terrible habits as not only to disqualify one for anything useful, but to destroy life itself. All of them make habits that are entirely beyond the control of most people.

Coffee, *tea*, *chocolate*, and similar beverages have a soothing, sustaining effect upon the nerves, unless taken to excess. But they form a mild drug habit, and finally produce sleeplessness, trembling, and disordered function; they upset digestion and affect the action of the heart. Failure to get them at the proper time is followed by a violent headache. This is the drug habit. There

is no food in any of these, and the habit should never be formed.

Alcohol acts directly upon the nervous system with its three well-known effects; then, through the nerves, it affects every function of the body. It can impair every system and every physiological act. Alcohol acts (1) as a stimulant, (2) then obstructs the action of the cells, and (3) finally produces paralysis. If taken to excess, it affects the brain, the stomach, liver, intestines, kidneys, lungs, muscles, nerves, skin, and the mind; it injures circulation, digestion, the excretions, respiration, motor action, voice, and all the special senses. It stunts bones in children and affects the nutrition of the bone in the adult; it destroys coördination in muscular action; it affects the mucous membrane of the digestive tract, making it dry, thick, and insensible, and ulcerates the stomach; it hardens the liver; it stimulates and then hardens all the glands of the body; it distends and weakens blood vessels; engorges the lungs; and impairs the mucous membrane in the lungs and other respiratory organs, preventing their proper function; it hardens the albumin in nerves and obstructs the action of the nerve centers; it weakens the nerves in all the special senses; and, finally, it is the chief agent in producing insanity; and, worst of all, its effects do not remain with one generation, but by heredity may descend to generations yet unborn.

Tobacco is a narcotic drug, its first effects being to soothe the cells, and produce a restful feeling; but somewhat like alcohol, it impairs most vital processes, and really aids none. Its action is slow, but very certain. The "tobacco heart" and "tobacco liver" are well known to physicians. Tobacco impairs digestion, circulation, respiration, and assimilation; it also interferes with the excretions, being especially hard on the kidneys. It is hard on the nerves, being very

injurious to the nerves of the young. Many a case of dyspepsia can be traced to tobacco.

Opium is a narcotic, a most useful drug in the hands of a physician, but one of the most dangerous drugs known; its first effect is to enliven and satisfy the mind somewhat like the first effect of alcohol; then comes a period of stupor and desire to sleep, with weakness of the nerves, and finally the whole body. A solution of opium in alcohol is known as laudanum. In time the patient has pains, bad digestion, sallow complexion, a bent spine and a very thin body. Then the wreckage is complete. It is more powerful in breaking down the moral sense than alcohol. Its danger lies in the fact that it makes one feel so good in its first effect.

Morphine is a drug, an extract of opium, and has the same narcotic effect. It is much more concentrated than opium. Its effects can be had much more quickly when, in a fluid state, it is injected into the body with a hypodermic needle. This drug should never be given by any one except a physician, and then only to save life. Most cases of morphine habit originate from first using it as a medicine.

Cocaine is an extract of coca (not cocoa), is a narcotic drug, and a good local anæsthetic. It is very useful, not so dangerous as opium or alcohol, but from its peculiar effects upon the nerves, is a very dangerous drug.

Indian hemp is a resinous narcotic found in the hemp plant. It produces a kind of temporary insanity, is very seductive and dangerous, but does not injure digestion and circulation as some other narcotics do. It is very injurious to the nerves and to the mind.

Chloral is made from chlorine, a deadly gas, and *alcohol;* it is a powerful narcotic. It is a dangerous poison, and is much used by physicians to produce sleep. It

impairs digestion, and in producing sleep often produces death.

4. Curing the Drug Habit. — Many drug habits can be cured; they can be cured by the victim if taken in time, by exercising restraint. If he cannot do it, physicians can usually break the habit by treatment.

OUTLINE SUMMARY

1. *Formation of Habit.*
   1. The law of life — activity; every cell must act.
   2. The law of habit — cells tend to repeat their acts.
   3. Results — cells permanently changed.
2. *The Drug Habit.*
   1. Stimulants — make cells act more rapidly.
   2. Narcotics — soothe and make cells act more slowly.
   3. Basis — tendency of cells to repeat their acts.
3. *Effects of Common Drugs.*
   1. Coffee, tea, and chocolate — effect soothing, but cause mild drug habit.
   2. Alcohol — results in one of the worst drug habits known. Make statement of effects.
   3. Tobacco — narcotic drug; impairs every vital act. Make statement.
   4. Opium — enlivens and satisfies, but ends in stupor.
   5. Morphine — produces a dense stupor; should be given only to save life.
   6. Cocaine — narcotic; good local anæsthetic; dangerous.
   7. Indian hemp — narcotic; produces temporary insanity.
   8. Chloral — powerful narcotic; impairs digestion.
4. *Curing the Drug Habit.*
   1. By restraint — patient may overcome by will.
   2. By medical treatment — any drug habit can be cured by use of proper drugs.

CHAPTER LIV

COLDS

1. Definition. — A *cold* is an inflamed condition of the mucous membrane of the body. Almost the whole body may be involved, but the inflammation gathers in some part of the mucous lining, any part of this lining being subject to an attack.

2. Cause. — The primary cause of colds is exposure to drafts, sudden cold, or long-continued cold wind, from which there is a sudden loss of energy, and lowering of the temperature of the body. There is a great effort of the body to repair the injury done by the cold; the activity of cells is increased, and extra blood is hurried to the injured parts. The first injury is caused by exposure, and the inflammation is produced by disease germs that gather rapidly at the seat of the injury.

3. Seat. — The mucous membrane is usually given as the seat of colds, because it is the point of inflammation; but other parts of the body may be equally concerned. In taking cold the skin is contracted, the pores suddenly closed, perspiration stopped, blood forced to the internal organs, capillary action checked, the nerves of the skin affected, and the elimination of poisons by the skin is checked or stopped altogether. At once, the lungs, liver, and kidneys are taxed to do the skin's work; the blood becomes overloaded with impurities; at the same time, the mucous membrane, being inflamed at certain points, becomes more or less affected, and its functions at all points impaired; and digestion, absorption, and intestinal elimination are deranged. The attack may center in the lungs, the throat, or the head, or all three; if the chief

FIG. 77. — Physician examining a throat.

attack is in the lungs, the cold is said to "settle on the lungs"; but if higher up, we have a "cold in the head"; in both cases breathing is obstructed, and the amount of oxygen decreased. The attack may be made upon the stomach, liver, or bowels, causing diarrhea, dysentery, or catarrh of the bowels. All this trouble greatly taxes some of the nerve centers, and impairs nerve action generally. The resistance of the body is lowered, and the approach of other diseases made easy. The real seat of the disease is or may be the whole body, and every vital function may be impaired.

4. Treatment. — To break up a cold, an attack on the disease must be made at every point affected. There are remedies that are suited to every organ troubled by the cold. The treatment of an ordinary cold consists of at least six steps: (1) restoring the skin to normal action, (2) clearing the respiratory tract, (3) stimulating the liver, (4) opening the bowels, (5) flushing the kidneys, and (6) sustaining animal heat. The function of the skin may be restored by causing a good sweat and then protecting the body against taking fresh cold; the respiratory tract can be cleared up by taking some expectorant, to relieve congestion and loosen mucus so it can be coughed up easily; the liver can be stimulated with calomel or some simple remedy; the bowels can be moved with an ordinary cathartic; the kidneys can be flushed with plenty of good water, or some simple diuretic; and animal heat sustained by plenty of good, heat-making foods and an abundance of exercise in the open air. In the treatment we must always guard against taking fresh cold. In case of a severe cold, or complications, seek medical advice.

5. Effect. — As a simple cold is functional, there should be no bad effects, if it is properly cured. If severe or

long continued, it may lead to a chronic catarrhal condition of any part of the mucous lining. By virtue of the increase of poisons, and the decrease of energy, it may seriously impair the function of any organ of the body. When a given organ is already weak, or overworked, the additional strain imposed by a cold may injure it for life; also, when some organ is already diseased, a cold may entirely destroy its prospects for recovery. The glands of the body are peculiarly affected by a severe cold. For these reasons, the breaking up of a cold is of first importance, and should be begun with the first appearance of the disorder.

6. **Prevention.** — Colds are usually taken when the body is overheated, or very tired; when under these conditions, if the body be exposed to a draft, a strong wind, or a cold room, a cold is almost sure to follow. A cold may be prevented by keeping every vital function in a normal state, avoiding drafts, cold rooms, and exposure to bad weather. One should avoid damp clothing, damp cold feet, damp bedding, and damp rooms. A cold body bath every morning in the year is not only a good tonic, but an almost sure preventive of colds, because it increases capillary circulation, and increases the resistance of the skin and nerve extremities; deep, cold breathing through the nose, taken in the open air several times a day, will aid in securing the same end. Windows of the bedrooms should be kept open almost all the time, especially at night, and wraps suited to the weather should be worn when out at night. The body should be trained to extremes of temperature as much as possible. It is well known that a cold is not always taken under the same conditions, because the resistance of the body varies greatly with the state of health and the state of mind. A cold is seldom

taken when the body is in action. It is easily worth all the time and care required, to keep the body strong at every point, and resistance high, as this will prevent a cold at nearly all times.

7. **Complications.** — The complications brought on by colds are numerous, and many of them are serious. The cold itself is far more serious than is usually supposed. Simple colds, as common as they are, lead to more serious troubles than any other functional disorder. Its chief danger lies in the fact that it enfeebles every organ it attacks, and leaves the organ, not only unable to perform its own function, but open to the attack of some disease. It is a forerunner of consumption, catarrh, indigestion, dysentery, pneumonia, Bright's disease, the fevers, and chronic liver troubles; it may complicate any of them, or almost any other functional or germ disease. A cold added to any disease already in progress makes the disease worse, because it lowers resistance, increases poisons, and disturbs function. A cold with measles, typhoid, consumption, smallpox, or pneumonia is very disastrous, and frequently fatal.

The discharge from a cold is very infectious, and should be sterilized as fast as it appears. It is produced mainly by bacterial action, and is composed of bacteria dead and living, mucus, waste materials, poisons, and sometimes pus. The discharge from colds should never be spit out upon floors, sidewalks, or in cars, but should be cast in some waste place, if it cannot be destroyed.

OUTLINE SUMMARY

1. *Definition.*
   1. Statement — an inflamed condition of mucous membrane.
   2. Organs involved — almost whole body may be involved.
2. *Cause.*
   1. Primary — exposure, resulting in congestion.
   2. Inflammation — caused by germs.

3. *Seat.*
   1. General — mucous membrane, any or all vital organs.
   2. Special — may "settle" on any organ, or system.
4. *Treatment.*
   1. Steps — six or more. Make statement.
   2. Fresh cold — prevent by taking proper steps.
5. *Effects.*
   1. Usual — should be no effect if properly treated.
   2. Probable — catarrh of mucous membrane; may injure almost any organ; severe on glands, and forerunner of consumption.
6. *Prevention.*
   1. Vital functions — by keeping them in a state of health.
   2. Hygienic measures — cold body bath daily, deep breathing, and ventilation.
7. *Complications.*
   1. Serious — more numerous and serious than supposed.
   2. Forerunner — of many diseases. Make statement.
   3. With other diseases — with consumption, smallpox, measles, typhoid or pneumonia, very disastrous.

CHAPTER LV

SOME COMMON INFECTIONS

1. Infectious Diseases. — An infectious disease is one that can be caught only by taking into the body, from without, a germ which causes the disease to develop in the body. It cannot be taken directly from another person; the germ must pass from a person having the disease to one who does not have it. Usually one cannot take an infection by merely being in the room a short time with a patient having it, or by waiting on the patient.

2. Contagious Diseases. — The distinction between the terms *infectious* and *contagious* is not very clear, and not very important for practical purposes; but a contagious disease is one that may be taken by merely being in the room with a person suffering from it, or by touching the patient, or by handling his clothing or bedding. They are germ diseases, or caused by the poisons which germs produce. Specific germs for many contagious diseases

FIG. 78. — Individual drinking cups hinder the spread of disease.

have not yet been discovered, but all diseases that are catching, whether contagious or infectious, are due to germs, or the poison they make. Typhoid fever is infectious, while measles and smallpox are contagious.

3. Erysipelas. — Erysipelas is a disease usually found in the parts surrounding a wound, or other seat of inflammation; it is caused by germs that get into the wound, and cause the parts near by to inflame, break out in pimples, and run in matter. It may occur at almost any point on the body. It can be prevented by giving the wound an early *antiseptic* dressing. It can be cured by remedies to kill the germs, reduce inflammation, and aid in healing; the parts should be kept sterile while treating the disease. Some good local remedies are peroxide of hydrogen, lead water and laudanum, carbolic acid lotion, and silver nitrate solution.

4. Diphtheria. — This is a very dangerous disease; it is caused by germs found in the saliva and throat secretions of a person afflicted with the disease. They can be inhaled by other persons who then may take the disease. While the disease is in the blood and throughout the body, its seat is the throat, where a false membrane is formed. It is a disease of childhood, but an occasional case in adults is seen. The only prevention is to keep children away from it, and the surest cure is the antitoxin of diphtheria, which can be given only by a physician. The germs can be carried in one's clothing, but can be destroyed by fumigation.

5. Pneumonia. — Pneumonia is a very fatal disease; it is an inflammation of the substance of the lungs, caused by a germ called the pneumococcus, which enters in the breath; in this disease a portion of the air sacs of the lungs becomes filled with a sort of mucus which contains

white corpuscles, blood plasma, poisons made by the germs, and other waste matter; this has to be coughed up. It is sometimes violent, runs a rapid course, and frequently ends in death. Pneumonia is nearly always preceded by a cold; it may be prevented by avoiding colds, and keeping the lungs in good condition; it can be cured only by a good physician.

6. Typhoid Fever. — This disease is one of the most fatal known to the medical profession; it is caused by a germ known as the *bacillus typhosus;* while the seat of the disease is a small place in the bowels, the patient is sick throughout his entire body; every tissue is attacked and distressed by the terrible germ. It can be prevented by disinfecting everything eaten, drunk, worn, or in any way used for the body. It is usually taken in infected water, but may be got from dust containing the germ, or through infected milk. If the body is perfectly healthy and strong, the disease will be warded off. As the fluids of the stomach, when normal, will destroy any disease germ, the best way to prevent it is to keep the stomach in a perfectly healthy condition, and then disinfect everything that comes in contact with the body. The germ comes from the discharges of a typhoid patient; it finds its way into drinking water, milk, food, and sometimes with dust into the air. When water or food containing it are boiled or cooked, the germ is killed. Flies carry the germs from place to place on their filthy legs. It may be carried in blood by insects that suck the blood from a typhoid patient, and then bite another person. It can be treated only by a good physician.

7. Cholera. — This is a malignant disease of the alimentary tract, especially the bowels. It is caused by the *comma bacillus*, which enters the body in water and

infected foods. The disease runs a rapid course, and usually ends in death. Cholera is usually found in tropical countries, but frequently extends far into temperate climates. It is always aided by bad sanitation ; filth, bad water, and poor drainage nearly always accompany it. It can be prevented by excluding the germ, and can be cured sometimes by the most skillful medical treatment. Modern sanitation has done much to overcome this disease. It is well known that if the stomach is normal, cholera cannot be contracted, but it is easily taken when the alimentary tract is in a catarrhal condition due to the use of unripe fruit, indigestible food, or alcoholic liquors. Pure air, pure water, pure soil, and pure habits will prevent cholera.

8. **Lockjaw.** — The proper name of this disease is *tetanus*. It manifests itself by a rigid contraction of the great massater muscle of the jaws which bring and hold the teeth together ; it is caused by a germ called the *tetanus bacillus*, which enters the body, usually, in some open wound ; an inflammation rapidly develops, with the result known as lockjaw. Prevention consists in cleansing and draining the wound and giving it an early antiseptic dressing, thus excluding the bacillus ; also by injecting antitetanic serum. It can best be cured by a *tetanus antitoxin*, aided by other suitable drugs.

9. **Grippe.** — Grippe is a nervous disease, caused by a germ known as the *bacillus influenza*. The disease runs a regular course of about six weeks, and the patient is very low-spirited. It is sometimes supposed to be a deep cold, but it may not have any connection with a cold. It may appear when the patient has a cold, it usually affects the respiratory tracts something like a cold, and may even cause a cough, but it is not a cold. It seems to attack the

whole nervous system. Prevention consists in adopting strict hygienic measures, and keeping one's self in the best nervous condition possible. It may lead to permanent nerve troubles, like nerve prostration, hysteria, or melancholia; it may leave a neuritis, or even lead to insanity.

10. **Measles.** — This disease has a regular incubation period of nine to twenty-seven days. The attack comes on with a high fever, headache, and a very bad taste in the mouth. Later a rash appears over the body when the disease is said to have "broken out." The disease is severe on the eyes, and the patient should be confined to a dark room and not permitted to read until well. The important thing is to force out the rash and keep it out until the disease runs its course. The rash may disappear too soon; then it should be forced out again. The patient should take every precaution to prevent taking cold at any time while sick. Ice water is a good means to force out the rash. The disease can be communicated at any time when the fever is on. The period of recovery is the most dangerous one for the patient; during this time he should receive especial care.

11. **Scarlet Fever.** — This is a very contagious disease, and is usually conveyed by means of the discharge from the throat and nose of a patient, and by the scales that fall from the skin during the course of the disease. It is usually confined to children. It has an incubation period of from two to fifteen days; it begins with a fever, and is followed by a rash. It is a serious disease. Prevention consists in isolation, and the treatment should always be intrusted to a physician. The patient should be carefully nursed in order to prevent bad results from the disease. Rest in bed, liquid diet, disinfection of all articles in the

room, and anointing of the body with cold cream or cocoa butter, are important measures.

12. Mumps. — This is a disease of the salivary glands, and is very contagious; it is caused by a specific poison or a germ, and may appear in both sides, or one side only. The only way to prevent it is to exclude the poison. It is inconvenient, but not regarded as dangerous. Rest, good hygiene, and good nursing are the essentials to recovery. The patient should not be permitted to contract cold while the disease is in progress. Isolation, rest in bed, and hot applications will usually relieve the patient. Ointments of belladonna and mercury are good for the local swelling.

13. Whooping Cough. — The proper name of this disease is *pertussis*. It is very contagious, and is contracted from the discharge of the throat and mouth of a patient while the disease is in progress. It runs a regular, self-limited course, and is not very serious if the patient is well nursed. A recovery is usually made if there are no complications. The patient should be isolated, and his personal articles disinfected. He need not be confined to bed, but should have a well-lighted and well-ventilated room. Inhalations of creosote and eucalyptol are good, and cloths dipped in solutions of these drugs may be hung about the room.

14. Smallpox. — Smallpox, once the most dreaded of all diseases, and one of the most fatal in former times, is now not regarded as very dangerous, if well handled. It is a very contagious disease, runs a regular course, and has an incubation period of from nine to forty-eight days; it begins with a high fever, which is soon followed by a very characteristic rash. It is taken from the discharge of the skin, and is not usually taken while the fever is on; it is not very contagious until the "pox fills," when the scales from the

eruption begin to fall; at this time the patient is getting well.

Smallpox is a serious disease, and should be in the hands of a physician from the first. The disease is made much milder by vaccination, after which it is called varioloid. In most cases it can be prevented entirely by successive vaccination. In the course of time the disease can be entirely stamped out by vaccination and good sanitation. A patient should not be allowed to go out until entirely well, and while being treated should be completely isolated.

Physicians seldom have the disease; they protect themselves against it by successive vaccination. People should be vaccinated every five years, and keep it up until the virus will not take effect; then they are safe.

15. Itch. — Itch, or scabies, is a very annoying disease caused by an animal parasite that burrows beneath the skin, and keeps up a constant irritation until it is killed. The disease usually appears between the fingers, or at the roots of the hair, but may appear in any part of the body. The treatment consists in applying a remedy that will kill the parasite, and then something to heal the wounds. If not checked in time, the disease will continue until great ulcers appear. It is contagious, and may be taken by touching the patient, or by handling articles used by him, as clothing, toys, or books. Perfect cleanliness of the affected parts is an essential.

A good remedy is a mixture of red precipitate and pure leaf lard; also undiluted kerosene oil applied several times a day. Nitrate of mercury ointment may be applied to the body. Styrax and balsam of Peru are most useful for infants. All clothing, sheets, and toilet articles should be sterilized.

SOME COMMON INFECTIONS

OUTLINE SUMMARY

1. *Infectious Diseases.* Definition.
2. *Contagious Diseases.* Definition.
3. *Erysipelas.*
   1. Cause.
   2. Prevention.
   3. Cure.
4. *Diphtheria.*
   1. Dangerous — false membrane in throat.
   2. Cure.
5. *Pneumonia.*
   1. Very fatal — inflammation of lungs.
   2. Prevention.
6. *Typhoid Fever.*
   1. Cause — bacillus typhosus.
   2. Prevention.
7. *Cholera.*
   1. Cause — comma bacillus.
   2. Found in tropical countries — bad sanitation.
   3. Prevention.
8. *Lockjaw.*
   1. Tetanus — caused by tetanus bacillus.
   2. Cure — tetanus antitoxin.
9. *Grippe.*
   1. Nervous disease — bacillus influenza.
   2. Prevention.
   3. Cure.
10. *Measles.*
    1. Symptoms.
    2. Treatment.
11. *Scarlet Fever.*
    1. Very contagious.
    2. Treatment.
12. *Mumps.*
    1. Very contagious.
    2. Treatment.
13. *Whooping Cough.*
    1. Pertussis.
    2. Course.
    3. Treatment.
14. *Smallpox.*
    1. Description.
    2. Prevention.
15. *Itch.*
    1. Scabies — parasite.
    2. Remedy.

CHAPTER LVI

TUBERCULOSIS

1. **Name.** — Consumption is the common name of a very fatal disease properly called *tuberculosis*. Other names are sometimes used according to the form or location of the infection, as phthisis, galloping consumption, cirrhosis of the lungs, tubercular laryngitis, and tubercular meningitis.

2. **Cause.** — The only cause of consumption is a germ known as the *tubercle bacillus*, which usually enters the body through the breath, though it may come through infected foods or drinks.

It is usually coughed out of the lungs of consumptives in the sputum, which soon dries and is blown away and perhaps inhaled by some one else. The lungs are usually thought to be the seat of this disease, but the germ may attack any tissue of the body, even the bones, and the infection begin there. These germs, like some others, may get into the lymph spaces of the body, and remain there for a long time without causing the disease until they attack and destroy some surrounding tissue. One can have tuberculosis of almost any organ.

3. **Prevention.** — Consumption can be prevented, (1) by keeping the body very strong, so it will resist the germ, and (2) by disinfection.

When the body is in perfect health, one will not take consumption. But the strongest persons sometimes contract the disease, because it is almost impossible for any one to be well always. Consumption is not inherited, but weak lungs may be inherited. For this reason it is easier for children of consumptive parents to take consumption. But persons having weak lungs can prevent it entirely by

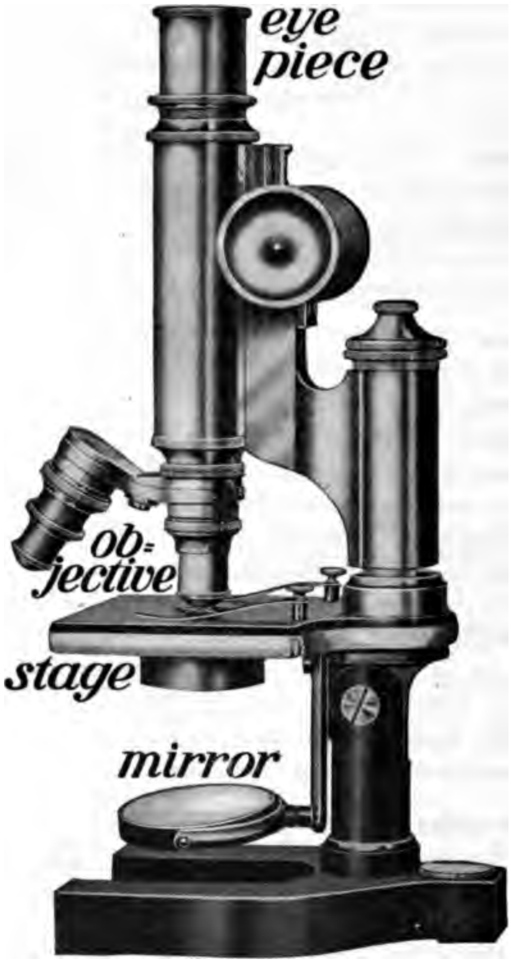


FIG. 79. — Compound microscope. Used in the study of germs.

proper care; weak lungs can be strengthened, and germs can be kept away.

No one should sleep with a consumptive, drink from his cup, eat food handled by him, or kiss any one having a cough.

Very great care should be taken to sterilize all sputum of a consumptive; all napkins, pasteboard cups, and paper used to receive the discharge from the lungs of a consumptive should be burned. Consumptives should not spit on the sidewalks, floors, or in cars.

All infected foods and drinks should be avoided; also low, dark, damp rooms. The strongest persons even should not sleep for one night in a room that never receives the sunlight and is poorly ventilated. Severe colds produce conditions that enable the germ to get a footing, while a person nervous, run down, or sick may not be able to resist it.

Sunlight and dry, pure air will soon destroy these germs. All articles of clothing, cutlery, cups, and dishes can be sterilized by boiling. Among the best disinfectants are bichloride of mercury solution and carbolic solution.

4. **Cure.** — Consumption can be cured. The disease appears in three stages: of those in the first stage fully 75 per cent to 90 per cent should get well; in the second stage, 40 per cent to 50 per cent should be cured; in the third stage, 15 per cent to 20 per cent should recover. A cure consists in destroying the germ and healing the wound it makes. Many persons, otherwise strong, take the disease and then overcome it and get well without any special treatment. Others inhale the germ and throw it off immediately, the germ not being able to get a foothold. Consumption may attack one at any age, but the younger and stronger the patient, the better the chances for recovery.

5. **Forms.** — There are many forms of tuberculosis, depending mainly upon the particular tissue attacked, as tubercular laryngitis, tubercular meningitis, tubercular peritonitis, and many others. Of consumption of the lungs there are four chief varieties: (1) galloping (acute,

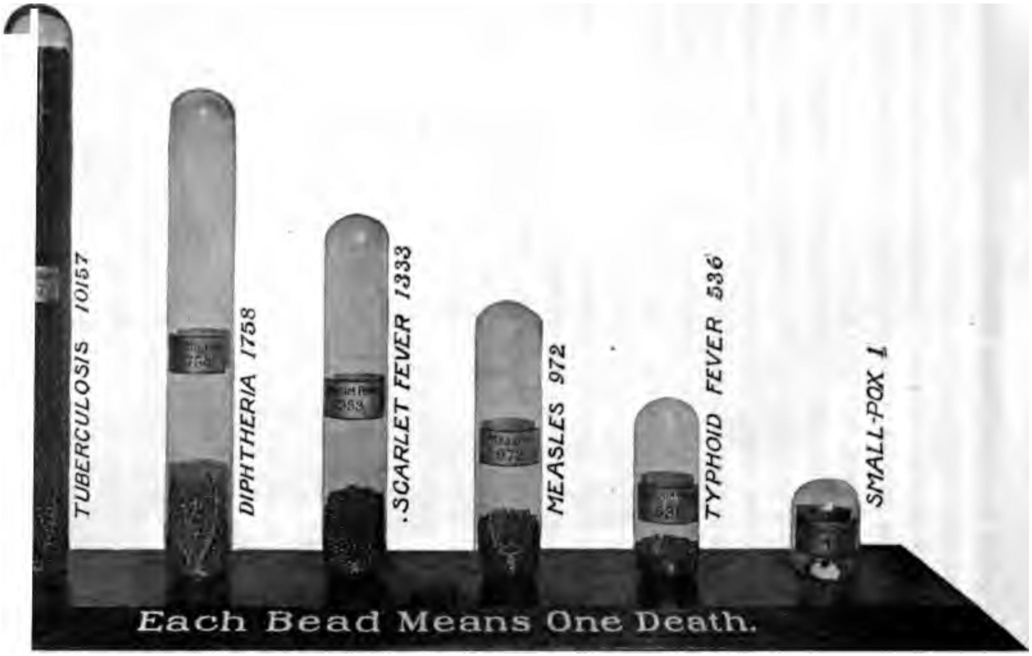


Fig. 80. — Relative fatality of some common diseases.

miliary tuberculosis), (2) catarrhal (pneumonic phthisis), (3) chronic ulcerative (tubercular phthisis), and (4) Corrigan's disease, or cirrhosis of the lungs (fibroid phthisis).

Galloping consumption often follows such diseases as measles, whooping cough, variola, and influenza. It is an acute form of consumption, due to the rapid growth of tubercles, and characterized by high fever, rapid pulse, hurried breathing, pain in chest, cough, profuse expectoration, and rapid decline. The onset is sudden, the course rapid, and the end usually death. The disease usually runs its course in from four to twelve weeks.

Catarrhal consumption is a form, more or less chronic, in which there is much destruction of the substance of the lung. It is accompanied by night sweats, fever, cough, shortness of breath, vile discharge from the lungs, and a more or less rapid prostration. This form of consumption may follow any infections, fever, bad hygienic surroundings, exposure, overwork, catarrhal pneumonia, or impaired general health. There are three varieties of this form of consumption, all of which usually result in death within a year or two.

Chronic ulcerative consumption is a chronic lung disease characterized by progressive failure of health, fever, cough, shortness or obstruction of breath, emaciation, and exhaustion. It usually follows bad sanitation, as dark, damp, overcrowded apartments, inherited weakness of lungs, catarrhal inflammation of the breathing tract, alcoholism, chronic Bright's disease, inhalation of foul air containing irritating particles, and a cramped position due to one's occupation, as that of stone cutters, glass cutters, and miners. The onset is insidious, usually attended by pallor, pain in stomach after meals, and great weakness. The slight dry cough at the beginning is soon increased, and expectoration is free. Morning chills, evening fever, and

night sweats appear. Emaciation becomes frightful, but the patient has a clear hopeful mind. The average person with this disease usually lasts about two years, and always believes he will get well, even to the last.

Corrigan's disease is that form of consumption in which there is a thickening of the connective tissue of the lungs. The lungs shrink and the bronchial tubes inflame. This is followed by a cough, profuse discharge, fever, emaciation, and death. In this, as in all other forms of consumption, the exciting cause is the *tubercle bacillus;* but bad heredity, bad sanitation, irritants inhaled, pneumonia, chronic bronchitis, alcoholism, and some other diseases open the way and prepare the soil for the germ.

6. Treatment. — The general treatment of consumption embraces as special forms of treatment (1) diet, (2) hygiene, (3) climate, (4) medicine, and (5) open air.

Dietetic treatment consists in choosing those foods that give the body the greatest strength and resistance with the least outlay of vital force. "Nourish the patient" is an ancient maxim in medicine, and never was applied more properly to any patient than a consumptive. The patient should have an abundance of good foods that are easy to digest, and should eat liberally; but there should be no overeating, and no indigestion in any form. It is of first importance to keep the stomach and other digestive organs in a state of perfect health, if possible. Foods to be used are eggs, milk, beef, poultry, game, fish, oysters, animal broth, and good bread. Water should be taken freely. Nothing should be fried. Foods to be avoided are pork, veal, crabs, lobsters, rich gravies, hot bread, cakes, pies, pastry and sweetmeats. Cod-liver oil and stomach stimulants should be taken with food to tone up the system. Alcohol should be avoided.

Hygienic treatment consists in following closely some special rules. The patient's apartment should be free from dampness, but the air should not be entirely dry, as it would induce coughing, and perhaps hemorrhage. The room should be perfectly ventilated, and receive the sunlight for several hours each day. The bedroom should be occupied at night only, and thrown open all day. The temperature should be 65° F. The patient should give the body a good bath each day, and follow it with friction, but avoid cold and shock. Cold sea bathing is harmful. Clothing should be warm and loose, not so heavy as to be oppressive, and changed with the seasons. Woolen or silk underwear should be worn throughout the year, and changed frequently. Rest and exercise should alternate so as to give vigor, but never exhaustion. Robust patients can take outdoor exercise, while weak, anæmic ones must have rest and only passive movements.

Sedentary occupations should be avoided, and cheerfulness and amusement cultivated.

Climatic treatment consists in adapting a climate suitable to the temperament and physical conditions of each consumptive. A favorable climate is one of the most efficient means of curing the disease. In an unfavorable climate it is almost impossible to effect a cure. Consumptives that are otherwise robust should have a high altitude, cold atmosphere, and a certain amount of rural hardship; while those who have a weak heart, nervous temperament, advanced lesions, and a tendency to bleeding, should have a low place with a warm, dry atmosphere. Good results are often obtained by placing a patient in an open country house in the hills having a dry atmosphere. The city is no place for a consumptive. Colorado and New Mexico may be taken as a type of high, dry climate; central South-

ern California represents warm, dry climates, and the coast of Southern California and Florida represent warm, moist climates.

Medical treatment of consumption consists in giving medicines for their general or constitutional effect, and for the relief of distressing symptoms. Cures can be brought about only by improving the general health and restoring the tone and resistance of the body. To this end, cod-

Fig. 81. — Open-air treatment.

liver oil combined with the hypophosphites of calcium, sodium, and potassium is an excellent preparation. Arsenic and strychnine are also useful. The serum treatment gives good results in some cases. Such symptoms as cough, dyspepsia, fever, night sweats, diarrhea, hemorrhage, and chest pains require separate medical treatment.

Open-air treatment of consumption, in specialized form, is comparatively new, and is by far the best way to treat the disease. It is most effective when intelligently com-

bined with other modes of treatment. The patient should be out of doors practically all the time, night and day, sleeping in a tent, on an upper porch, or a balcony. Where this is not possible, a room in an open log house will serve the purpose, or an ordinary unplastered room with widely opened windows. This mode of treatment can be made effective almost anywhere except in damp places.

Consumption, known as the "white plague," has caused more deaths than any other one disease; more than half the human race have been infected with it. Since it can be prevented in nearly every case, and since more than half of all cases can be cured, the white plague should be stamped out of existence. Scientific methods have done much to overcome it, and it is believed that the day will come when cases of consumption will be rare.

OUTLINE SUMMARY

1. *Tuberculosis.*
   1. Consumption — very fatal disease.
   2. Other names — give list.
2. *Cause.*
   1. Germ — tubercle bacillus — usually enters in the breath.
   2. Location — may attack any tissue.
3. *Prevention.*
   1. General health — must be built up.
   2. Germs — how destroyed.
4. *Cure.*
   1. Stages of the disease.
   2. Percentage of cures.
5. *Forms.*
   1. Galloping — acute; usually fatal.
   2. Catarrhal — description; causes.
   3. Chronic — description; causes.
   4. Corrigan's disease — effect on lungs.
6. *Treatment.*
   1. Dietetic — good food; water; no alcohol.
   2. Hygienic — special rules; clothing; exercise.
   3. Climatic — climate adapted to patient.
   4. Medical — medicines for general health.
   5. Open air — best; description.

CHAPTER LVII

ACCIDENTS AND EMERGENCIES

1. **Accidents.** — Accidents are sudden, and usually exciting. The first essential to good work is a cool head. One should determine the best means to aid sufferers, and then act quickly. To be of much aid to the sick and wounded every one should know something of the human body, and something of practical means to relieve suffering and save life. Every home and every school should have a small medicine cabinet, and a small stock of well-known medicines, some bandages, adhesive plasters, some needles and thread, gauze, and absorbent cotton. In case of accident keep crowds away from the injured, have plenty of air, and plenty of room to work. The psychic effect of an excited, curious crowd is not good for the patient.

2. **Emergencies.** — Emergencies, also, arise in the life of every one, and usually appear at the most unexpected time. In emergencies connected with fainting, convulsions, hemorrhage, or poisoning, a human life may depend on our knowing what to do, and being able to act quickly; in such cases we cannot wait for a physician, but must be able to apply simple, effective remedies.

3. **Fits.** — A fit, spasm, or convulsion as it is sometimes called, is caused by a disturbance of the motor areas of the brain; it may be violent, when the sufferer may do himself or others great injury; or it may be mild, a simple tremor and unconsciousness, with no disposition to violence. Usually the patient loses muscular coördination, rolls his eyes, foams at the mouth, and bites his tongue and lips. First see that the patient is properly confined, so no violence can be done to himself or others; put a folded handkerchief

in his mouth to keep him from lacerating his tongue and lips, loosen his clothing, especially about the neck and chest. Keep crowds away and give the patient plenty of fresh air. After the fit passes away, keep the patient quiet for some time. If the fit is due to epilepsy, the bromides in some form should be used.

4. **Foreign Bodies in the Throat.** — When foreign bodies lodge in the throat, remove them with the finger if possible; if this cannot be done, slap the patient sharply on the back several times; if this does not pass the object, make the patient vomit. Sometimes heavy artificial breathing will cause the object to pass. When foreign bodies are swallowed, such as coins, fruit stones, marbles, short pencils, and shoe buttoners, it is well to remember that whatever can pass into the stomach can pass on out. It is best not to give a cathartic, but to have the patient eat plenty of good food; the foreign body will pass off in the ordinary way.

5. **Bleeding at the Nose.** — A light attack of nose bleeding will stop of itself by the coagulation of blood; cold water or a solution of alum is useful. Usually compressing the nostrils with thumb and finger is sufficient. If the flow continue, keep head erect, take several deep breaths, filling the lungs well each time; place a cold wet towel around the neck, and a cold wet handkerchief against base of the nose. Raise and hold erect the arm on the bleeding side. The finger may be passed into the nostril and pressed upon the bleeding point; or, fill the bleeding nostril with gauze or absorbent cotton sufficient to create pressure. If this does not stop the flow, send for a physician.

6. **Dog Bite.** — If the dog is not rabid, cleanse the wound thoroughly, sterilize with a weak solution of carbolic acid, and bind the wound. If bitten by a rabid dog, clean the

wound well, wash thoroughly and quickly with sterile water, and apply suction with mouth; as soon as this is done, cauterize the wound with some hot instrument like a poker, knitting needle, or hair curler, by passing the hot instrument over the wound until it is seared. Then wash the wound in a weak solution of carbolic acid, and apply a warm poultice. If complications arise, treat each as the case demands. If the dog is not certainly known to be mad, do not kill it until this can be ascertained. It may not be rabid. Treat bite of other rabid animals in a similar way.

7. **Snake Bite.** — If bitten by a snake that is not poisonous, treat as in any ordinary wound; that is, cleanse, sterilize, and bind the wound. If bitten by a venomous snake, lose no time. Suck out the poison from wound; then cut away some of the tissues about the wound, sterilize, cauterize well, and dress it in carbolic acid or ammonia. Give patient a stimulant, such as ammonia or strychnine, or give plenty of whisky or brandy; in case alcohol is used, it must be kept up until danger is passed. Remember that this poison is carried quickly to all parts of the system. Get a physician as soon as possible.

8. **Sting of Insect.** — Remove the sting, and bathe the wound in ammonia water or weak carbolic acid; then apply sweet oil, vaseline, or lanoline; if these are not at hand, cover the wound and surrounding tissue with dampened salt. The swelling can be reduced with cold applications.

9. **Fractures.** — A fracture may usually be known by loss of function, loss of motion, crepitation (sound of broken parts), pain, and deformity. Treatment consists in placing broken parts in proper positions, binding them

there, and then supporting the limb or injured parts so as to give relief and promote union of the broken parts. An arm should be suspended in a sling, while a leg should be kept straight, and held in place by splints, or put up in plaster. If a joint or the cranium is fractured, put broken parts in place if possible, so as to give patient ease, and call a surgeon. If tissues about the fracture are lacerated, torn, or punctured, treat as any other wound. These injuries are serious, and all fractures should be treated only by experienced persons.

FIG. 82.—Fractured arm supported in a sling.

10. Bruises. — A bruise consists of crushed tissue, broken capillaries, and free blood among the tissues. A bad bruise may be accompanied by shock; if so, the shock must be treated. To treat a bruise, keep it protected from clothing, sterilize, and apply cold wet cloths to reduce the swelling and pain. If the pain is very great a local anæsthetic may be needed. Let the bruised part rest. The blue or black color of the bruised tissue will disappear by absorption, which may be hastened by use of some liniment to soften tissues and increase capillary circulation.

11. Shock. — Shock is a derangement or exhaustion of the nerves, caused by injury or great fright; it may be accompanied by a great rush of blood to the internal

organs, nervousness, and sometimes fainting. It is usually shock that causes one to fall when shot, stabbed, or struck on the head or abdomen. The unconsciousness that first comes is usually a form of fainting; this may be followed by unconsciousness from poison or brain injury. The patient should first be treated for fainting, and unless the injury is great, he can usually be restored to consciousness. In addition to treatment for fainting, the nature of the injury must be taken into consideration; while unconscious the limbs should be straightened and rubbed, ammonia should be inhaled, a little cold water drunk, and a good heart stimulant like strychnia given. If the person is to be carried, do not double him up, but put him on a board or stretcher, keep the limbs and body straight, and handle him gently. Many a death is caused from shock.

If the shock is not accompanied by unconsciousness, give a stimulant, and put the patient to bed.

12. Hiccough. — This is a series of short inspirations caused by the spasmodic contraction of the diaphragm. It is usually caused by some excitement or indigestion, and will cease of its own accord. It can usually be cured by doing anything that will cause the diaphragm and muscles of the chest to be engaged for a short time, as deep breathing exercises, calisthenic exercises, or repeated swallowing of small sups of water for a few minutes. The will is a useful factor in obstinate cases. Sometimes it becomes so violent as to require medical aid; it may even cause death.

13. Toothache. — This is usually caused by exposure of a nerve to the air, to particles of food, or to an acid. Put a bit of cotton saturated with creosote, salt water and camphor, oil of cloves, or kerosene into the cavity of the

tooth, and protect the lips and gums with a layer of dry cotton over the pledget put in the tooth. If the cavity is too small for the cotton, a small drop of the remedy may be put into the cavity, and the lips and gums protected as above. Apply heat from a water bag, salt bag, cloths, or a flat iron to the outside in region of tooth. When the pain ceases, protect the nerve by filling the cavity with cotton until a dentist can be reached.

14. Earache. — For acute earache apply heat from water bag, flat iron, or salt bag; drop a little sweet oil and laudanum in the ear. If an ear is inflamed, a good remedy can be made of sweet oil (two parts), laudanum (one part) and strained honey (one part); warm the mixture, and put from four to six drops in the inflamed ear, and close it up with cotton. Another good remedy is made by substituting onion juice for the honey in the above remedy.

15. Poisons. — A poison is a substance which will prevent the function or destroy the life of the cells of the body. Foods are exactly the opposite, aiding the function, and promoting the life of the cells. Poison destroys life at the cells primarily, later it extends to the tissues through the cells, and finally destroys the vital functions. Some poisons begin their deadly work as soon as they are taken into the throat, as acids, alkalies, and arsenic. Others, as alcohol, opium, and aconite, are absorbed in the stomach and intestines, and do but little mischief until they reach the cells.

16. Emetics. — An *emetic* is a substance that will cause vomiting, and the process is called *emesis*. The quickest way to get a poison out of the stomach is by emesis; this is also a good way to get rid of a large or indigestible meal. Some good emetics are (1) a teaspoonful of ground

mustard in a half pint of warm water, (2) a half pint of warm strong salt water, (3) sulphate of zinc, about a dessert spoonful to a pint of water, giving a large drink every two minutes until emesis is produced, (4) a few large drinks of warm water, (5) warm soapsuds, and (6) the pushing of the finger or a feather far down the throat. In case of poison, vomiting should be continued until all poison is removed.

17. **Antidotes.** — An antidote to a poison is a substance that will overcome the poison, and prevent its effects in the body. There are two general classes of antidotes: (1) *chemical*, and (2) *physiological*; a chemical antidote enters into chemical combination with the poison, and forms a new substance that is harmless, neutralizing the poison; a physiological antidote opposes the action of the poison by producing an opposite physiological effect, and in this way neutralizes the action of the poison. Some poisons do not seem to have any special antidotes. In all such cases, the best thing to use is some common oil, or grease, or some pasty substance like cream, milk, olive oil, butter, white of egg, starch, or flour in water. These quickly coat the stomach and prevent the absorption of poison. Oils or grease may be used with any poison but phosphorus.

Below are a few common poisons, and the antidotes that should be used. In general, *acids* are antidotes to *alkalies*, and *alkalies* are antidotes to *acids*. An acid is a substance sour or sharp to the taste, and the chemical opposite of alkalies; some examples are hydrochloric acid, sulphuric, nitric, acetic, and oxalic. An alkali is a substance bitter to the taste, of soapy feeling, and the chemical opposite to acids; lye, potash, soap, ashes, lime, and ammonia are good examples.

ACIDS.

Carbolic	Give emetic; follow with some alkali like chalk, or magnesia in water; then give melted butter, olive oil, or flour in milk or water.
Oxalic	Give emetic; follow with lime water, then melted butter, or olive oil.
Muratic *Sulphuric* *Nitric*	Give emetic; follow with an alkali in water, like lime, magnesia, soap, or chalk; then give melted butter, cream, olive oil, or flour in milk.

ALKALIES (caustic).

Ammonia *Caustic Soda* *Caustic Potash* *Lye (concentrated)*	Give good emetic; follow with an acid like lemon juice or vinegar; then give melted butter, olive oil, cream, lard, or flour in milk.

OPIUM.

Colic Mixtures *Morphine* *Laudanum* *Paregoric* *Soothing Syrup* *Cholera Mixtures*	Give emetic freely; follow with plenty of strong coffee. *Keep patient awake* by exercise, dashing cold water in face, and irritating him.

ARSENIC.

Paris Green *Fowler's Solution* *Rat Poison*	Give emetic freely; follow with some form of iron (its antidote) if possible, like oxide of iron; then give salt and gruel, milk and raw eggs, lime water, or flour in water or milk. Rush in a doctor.

PHOSPHORUS.

Rat Poison *Matches*	Give an emetic; follow with lime water, magnesia and water, or soap and water, chalk or whiting in warm water. *Do not give any form of oil, fat, or grease.*

VEGETABLE POISONING.

Tobacco *Toadstools* *Hemlock* *Poison Berries* *Poison Vines*	Give emetic freely; follow with stimulant like coffee, or weak ammonia; then lime in water, magnesia in water, or soap in water.

STRYCHNIA.

Strychnine *Nux Vomica* *Dog Button* *Rat Poison*	Give emetic freely; follow with flaxseed tea; then if necessary, give belladonna or opium under medical advice. Keep patient in dark room. Remember that convulsions with flexure of body may appear.

ACONITE.	Give emetic freely; follow with such stimulants as coffee or ammonia.
BELLADONNA.	Give emetic freely; give tannic acid, or opium carefully; follow with strychnia if needed, only upon medical advice.

PRUSSIC ACID. CYANIDE OF POTASSIUM.	Give emetic quickly and freely; follow with teaspoonful of hartshorn in a glass of water; then stimulate respiration, dash cold water in face. Very fatal.
LOBELIA. COLCHICUM.	Give emetic freely; follow with an abundance of castor oil.
MERCURY.	
Bed-bug Poison *Calomel* *Blue Mass* *Corrosive Sublimate* *Red Precipitate* *Vermilion*	Give emetic; follow with white of egg, flour in milk or water, or linseed oil.
IRON.	
Copperas, or Green Vitriol	Give emetic; follow with magnesia or soda and water.
COPPER.	
Blue Vitriol *Verdigris* "*Greened Pickles*" *Poisoned Foods*	Give emetic; follow with milk, white of egg, and strong tea. *Acids must not be given.*
SILVER.	
Nitrate of Silver, or lunar caustic	Give emetic; follow with castor oil, and flaxseed tea.
LEAD.	
Sugar of Lead (acetate) *White Lead* (paint) *Red Lead* (paint)	Give emetic; follow with epsom salts, a solution of 2 oz. to pint of water, taking wine glass full every few minutes. In case of lead colic, see a physician.

IODINE. Give freely starch and water, or flour and water.

CHLOROFORM, ETHER, or CHLORAL.	Throw cold water in face; employ artificial respiration, suspend patient by feet, and slap body sharply.

OUTLINE SUMMARY

1. *Accidents.*
   1. Cool head essential.
   2. Medicine cabinet.
   3. Crowd — kept away.
2. *Emergencies.*
   1. Promptness.
   2. Knowledge of simple remedies.
3. *Fits.*
   1. Description.
   2. Treatment.

4. *Foreign Bodies in the Throat.* Treatment.
5. *Bleeding at the Nose.* Treatment.
6. *Dog Bite.*
    1. Ordinary cases.
    2. Of rabid animal.
7. *Snake Bite.*
    1. Ordinary cases.
    2. Of venomous snake.
8. *Sting of Insects.* Treatment.
9. *Fractures.*
    1. How known.
    2. Treatment.
10. *Bruises.*
    1. Defined.
    2. Treatment.
11. *Shock.*
    1. Defined.
    2. Treatment.
12. *Hiccough.*
    1. Defined.
    2. Treatment.
13. *Toothache.*
    1. Cause.
    2. Treatment.
14. *Earache.* Treatment.
15. *Poisons.*
    1. Defined.
    2. Treatment.
16. *Emetics.*
    1. Defined.
    2. List.
17. *Antidotes.*
    1. Defined.
    2. Classes.
    3. Study list.

CHAPTER LVIII

SLEEP

1. Rest. — The heart rests about half the time. No other muscle works so much, excepting, perhaps, some of the respiratory muscles. Voluntary muscles cannot work half the time. The brain cannot do continuous

work for half the time without loss; it must work, then rest, all day long, most of its activities being very light. Fully half the time must be given to the work of repair, and some organs require much more. Repair goes on, to some extent, nearly all the time. But the repair of all the waking hours is small, while the wear is large, far in excess of the repair. To keep the body from wearing out, nature has provided a way called *sleep* which affords rest for all the body. For sleep to be good, all the activities of the tissues must be suspended, excepting those engaged in the work of the vital processes; repair can be done best only at the time when there is no waste going on.

2. **Amount.** — On an average of the whole of one's life, at least one third of the time must be spent in sound, restful sleep. For this amount of sleep to be sufficient, it must be unbroken, and undisturbed with restlessness, nervousness, or dreams. One should fall asleep gently, and not wake until he has slept his allotted time. If rest is disturbed, and sleep broken, much more sleep will be required. All hard brain workers, and those with large responsibilities should form the habit of a short sleep of fifteen or twenty minutes just before the noon meal; this should be long enough to break the nervous strain, and not enough to make one feel drowsy. Most children need ten hours or more of sleep, all adults fully eight hours, and old people all their systems will take. All brain workers, especially students, lose in both quality and quantity of their work by loss of sleep.

3. **Time.** — The best time to sleep is *at night*. One's health is never quite so good when he must work at night and sleep in the day, because repair is not so well done, nor rest so perfect. People who sit up, work, or dissipate until midnight or after, and then sleep until nine or ten

o'clock next day, are not only losing personal power and losing the best hours in the day for work, but are shortening their lives. One should be up by sunrise; an hour earlier is even better.

4. The Room. — A bedroom should be on the second floor or higher, because there is better air, less noise, and less dampness; it should be in a quiet part of the house. It should be a plain room with a good bathroom attached, two to four windows with outside shutters, high ceiling, and with secure locks. The ventilation should be perfect; the window sash should be so hung as to move up or down and should be left open almost all the day and should be wide open at night. Sleepers should be protected against cold by warm bed clothing, and against drafts by outside shutters and some screens if necessary. The air should move freely in the room at all times without making a draft. The room should have a flood of sunlight during the greater part of the day, every article of furniture and bedding receiving its rays if possible. For bedding, air and sunlight are as important as washing. Heat from an open grate is best for a bedroom.

5. Furniture. — The bedroom should have a polished floor and a few rugs that can be easily removed, dusted, and aired; if carpeted at all, the carpet should be woolen and of good quality; a few good chairs, a toilet set if there is no bathroom attached, wall paper of restful figure and cheerful tint, a few pictures of high grade, suggesting rest and quiet, and double window shades hung both from above and below. The chief article of furniture is the bed itself; it is best when made of iron, brass, or wood that will take a high polish; the springs should be strong, closely woven, and flexible, and have a smooth surface; on the mattress there should be placed a mat of cotton or a

very light feather bed, but never a large feather bed, for it is not healthful. Some good pillows of medium size, plenty of linens, and some good blankets and comforts will complete the bed; when put up, the bed should be level, *clean* in every part, and uninhabited; it should smell good and be a thing of beauty. With such a room, good conditions, and a clear conscience, one should sleep like a babe.

6. **Physical Condition.** — The bedroom should be cool if possible, never warmer than the outside air, except in extremely cold, stormy weather or in very cold countries. An electric fan for hot weather is a very useful appliance. The body of the sleeper should be in a perfect state of health, the stomach almost or quite empty, and the circulation equalized. Sometimes a light lunch just before retiring induces sleep, but it should be very light. No meats should be eaten at night, especially by brain workers, and no alcohol taken. One should train himself to sleep in any usual position, on either side, and on the back. The head should be in line with the body, that is, without a pillow when lying on the back, and with just pillow enough to keep the head on a level when lying on the side. Nearly all persons should sleep alone, excepting such persons as have about the same temperament, same age, same amount of animal heat, and the habit of sleeping at the same time.

7. **Mental Condition.** — The mind, like the body, must be at rest. If we take our joys, sorrows, worries, and work to our bedrooms, we can never have refreshing sleep. For sleep to be welcome it is well for both mind and body to feel a little fatigue. Thinking over the events of the day, after retiring, is a bad practice. One *should look* forward to sleep with great joy.

8. Dreaming. — Dreams are caused by partial cerebral action, or uncoördinated cerebral action; this is usually the result of some bad physical condition, or some undue mental state. There are no dreams in sound sleep. Disturbed circulation, a pain, indigestion, overeating, alcohol, fever, overwrought emotions, as grief, joy, and worry, are common causes of dreaming. Dreams are not foreshadows of future events, but echoes of the past. People who dream do not get good rest. Relating dreams to friends next day is a bad habit. One should not try to remember them. Remove the conditions that cause them, then *resolve not to dream*, and dreams will cease. Vivid images, and the utter confusion of figures, fact, and fancy, are due to uncoördinated cerebral action; a portion of the mind is suspended, and the active faculties are not balanced. It is an abnormal state. Occasionally a student may do a good piece of work when dreaming, but it is only when coördination is almost perfect, and the dream state is almost equal to the conscious state.

9. Insomnia. — Temporary functional insomnia is due to too much blood in the head, or nervousness. Worry, idleness, and deranged function are common causes. One has to relax in some way, and equalize the circulation; a warm bath, a friction bath, or a cold bath followed by friction will return the blood to the capillaries, and relieve the brain. For nervousness, a light dose of some good nerve sedative to soothe and quiet is good, to be followed next day with a nerve tonic. Strong narcotics should never be taken to induce sleep. If the mind is excited and running at a rapid rate, the attention should be fixed upon some one pleasant, or trifling thing; this will break the train; cerebral excitement will cease, and sleep will follow. If the attack is long continued, consult a physician.

10. Nightmare. — This is usually the result of poor, or obstructed circulation; it is a form of dreaming. The dreamer thinks that he is in great distress or danger and is unable to get help or to help himself, although help is usually in easy reach; one fancies himself falling from a housetop, or surrounded by dangerous reptiles, with no means of protection; there are many forms of nightmare; the state is more or less unnatural and very distressing.

11. Somnambulism. — In this state, the sleeper actually performs some acts that belong to the waking state, such as walking, climbing, or laboring. One man was known to get up, dress, harness his team, and begin plowing before he awoke. This state is frequently attended by great danger.

OUTLINE SUMMARY

1. *Rest* — sleep; activities suspended.
2. *Amount* — about one third of the time. Children need more.
3. *Time* — night; late hours shorten life.
4. *Room* — high and dry; well ventilated.
5. *Furniture* — simple; no carpet; metal bedstead; mattress; coverings.
6. *Physical Condition.*
   1. Cool — stomach nearly empty.
   2. Position — head in line with body.
7. *Mental Condition* — mind at rest; worries laid aside.
8. *Dreaming* — causes; abnormal state.
9. *Insomnia* — causes; relief.
10. *Nightmare* — form of dreaming; unnatural state.
11. *Somnambulism* — dreamer performs act; walking, etc.

CHAPTER LIX

THE SICK ROOM

1. Location. — The sick room should be in a quiet, secluded part of the house; it should be on the first floor, *but free from* dampness or fumes from a cellar, and from

the odors of the kitchen. It should be easy of access, bright and cheerful; and it should be entirely secluded from the play of children, the gayety of society, and the noise of musical instruments.

2. **Construction.** — In construction, the room should be simple, plain, and large; it should have from two to four good windows with outside shutters and hanging sash, well made and supplied with hooks and locks. It is better to have windows in two sides of the room in order to get sunlight nearly all day and to ventilate as may be desired; the room should have an open grate for heat, and a good bathroom attached; it should not have a staircase, nor too many closets.

3. **Furniture.** — The room should not have any needless furniture; there should be no bric-a-brac, draperies, carpet, and no upholstered chairs, couches, or settees; there should be no pictures except such as are restful or cheerful, and no books. There should be a good bed of iron or brass, supplied with good springs, and an even, flexible mattress; feather beds should never be used; the bed should have plenty of linens, several clean, downy pillows of medium size, blankets and comforts to use as needed, and some means for turning a patient. The room should be supplied with two or three plain chairs, a polished or painted floor, a few strips of carpet to deaden the sound of footsteps and electric or gas lights if possible. Unpapered walls are better, but if papered, the tints should be subdued and restful. The windows should have good shades that may be drawn from bottom or top.

4. **Heat.** — Heat from a grate is best because it admits of considerable ventilation and does not take the moisture out of the air; a hot water radiator is next best, then steam,

then hot air, and finally an inside stove. The greatest danger is in keeping the patient too warm. The heat should be as uniform as possible, and should never stand above 70 degrees. There should be two thermometers at different points of the room. All sudden drafts of cold air should be avoided.

5. **Ventilation.** — It is of first importance that the room have an abundance of fresh air all the time; a constant change of air without drafts should be the aim. If the room is not supplied with ventilators, the windows should be opened enough to admit of a free exchange of fresh air all the time. If nothing better can be done, cover the patient well with bed clothing and open wide the windows, occasionally. Usually, when windows are adjusted for regular ventilation, the patient can be protected with a screen about the bed. The room should be kept free from all disagreeable or foul odors. Fresh air is one of the means of destroying germs.

6. **Light.** — Sunlight is one of the most effective means of killing disease germs. A sick room should have an abundance of it all day; window shades can be so drawn as to protect patients from excessive light, but it is as important to flood the room with sunlight occasionally as to flush with pure air. The sun's rays should fall upon the patient's bed at some time in each day. A well-lighted room has a fine psychic effect, also; a cheerful, bright room aids recovery, while a dark, gloomy room retards it, besides breeding disease germs.

7. **Medical Appliances.** — The room should have a small medicine case, or a table for all bottles, tumblers, pitchers, and instruments. If there is not a bathroom annexed, there should be a good washstand and toilet set, and a

place to put away a bedpan, hot water bag, catheter, and like appliances. All of these should be kept out of the sight of the patient, and should be kept clean and disinfected. Drinking water should not be kept in the room, but should be fresh each time used, and all unused food should be taken out promptly and destroyed. Medicines should be labeled clearly, and all poisons locked up. Pastry, confections, and fruit should be kept out of the room. Spoons, cutlery, and drinking cups should be cleaned as used.

8. **Disinfection.** — If the instruction regarding ventilation and sunlight can be followed, further disinfection becomes easy. Whatever additional disinfecting is done should be under the direction of the physician; an occasional carbolizing of the room is good if not offensive to the patient. All vessels should be sprayed out with some good disinfectant, excreta burned, and underclothing and bed linens boiled. Perfuming a room does not disinfect it, and may cover up noxious odors; the burning of the pastilles do not destroy bad odors, and is disagreeable to the patient. Pillows, blankets, and comforts should be given an airing and sun bath every day.

9. **Cleanliness.** — *Perfect cleanliness is absolutely necessary.* All clothing, towels, napkins, and linens must be frequently changed, and all soiled articles promptly removed from the room; they should be boiled and laundered as soon as possible. Fresh flowers each day are very helpful in the sick room. One should be cleanly at all times, but doubly so when sick. If people were perfectly cleanly in every way, most sickness would be prevented entirely; if the sick room were always clean and sanitary, human suffering would be greatly diminished, many a life saved, and many an epidemic avoided.

10. Caring for the Patient. — In serious illness, a physician and a nurse should be employed. When a physician takes charge of a case, his orders must be strictly obeyed. All his directions to both nurse and patient should be carried out faithfully, and nothing done for or given to the patient except by his directions. Nurses and members of the family should never change a remedy or adopt a new course merely because some well-meaning but ignorant friend suggests it. When the point is reached that the doctor's advice cannot be followed, then get another doctor.

Good nursing is usually half the battle; the nurse is trusted to carry out all details, and to care for the patient. She should be cheerful, intelligent, and faithful. She should be given control of the room and the patient, and her suggestions should be heeded. It is her duty to see that all the hygienic rules of the sick room are obeyed, and that the patient is protected against noise, company, and all discomforts.

If a trained nurse is not employed, nursing should be intrusted to but few. If there be need of some one through the night, there should be but two persons waiting on the patient, one in the day and the other at night; both should be experienced in the sick room, and know something of symptoms and the effects of drugs.

Company, however pleasant, should be kept from the patient. All noises should be avoided. All talking in the presence of the patient should be in a natural tone and pitch of voice. Whispering should be forbidden.

In case of contagious diseases, isolate the patient perfectly and disinfect until all chance of spreading the contagion is removed.

OUTLINE SUMMARY

1. *Location* — sick room; quiet; cheerful.
2. *Construction* — simple; light; airy.

3. *Furniture* — few pictures; metallic bedstead; mattress; plain chairs; bare floor; plain walls.
4. *Heat* — moderate; uniform.
5. *Ventilation* — abundance of fresh air.
6. *Light* — sunlight essential.
7. *Appliances* — medicine case; water and food; brought in when needed; remove promptly.
8. *Disinfection* — fresh air; sunlight; no perfumes.
9. *Cleanliness* — absolutely necessary; soiled articles removed; flowers.
10. *Caring for the Patient* — physician's directions should be carried out.

CHAPTER LX

URIC ACID

1. Definition. — When alcohol is used to excess, lung capacity reduced below normal, the stomach obstructed in its work, intestinal digestion poor, or the liver is unable to do its great work, oxidation of the food will be imperfect, and much unoxidized food which the cells cannot take up and use, will float around in the blood. These food elements unite with some waste elements already in the blood to form a very poisonous substance called *uric acid*. It is one of the most destructive poisons the body has to deal with.

2. How Made. — Uric acid is made of the unoxidized, unused portions of foods, and other waste products in the blood. If we get the proper amount of fresh air, eat only real foods, do not overeat, discard alcohol altogether, take enough physical exercise, and digest well, we shall never have uric acid at all. But living is so faulty that most people have some of it at times. To get rid of it, one must correct his living.

3. Effects. — Uric acid produces two general effects: (1) it attacks any tissue of the body directly, and (2) it aids almost any disease in its attack upon the system.

In the first effect, it poisons the tissues, and overtaxes the excretory organs. The effect is usually shown upon the kidneys first; uric acid not only overworks that organ, but poisons its tissues, rendering it much weaker; inflammation may set in, and Bright's disease may follow. If the kidney is strong enough to withstand the attack, uric acid usually attacks one in the next weakest place. It may go to the brain, liver, muscles, heart, stomach, intestines, or the joints. It prevents cells from performing their functions, and also poisons the cell itself, in many cases hardening it, causing the cell to shrink, or break down altogether.

4. **Diseases it will Aid.** — Uric acid is a great factor in rheumatism in all its forms. In inflammatory rheumatism, uric acid makes it easier for the disease to get a foothold; in muscular rheumatism it is a chief cause; and in articular rheumatism, it aids in the formation of the deposits in joints, and loss of the synovial function; in nerve diseases, it is a stubborn factor. Uric acid makes it easier for neurasthenia, epilepsy, hysteria, and paresis to start, and makes them worse in their entire course. It makes worse all functional troubles like dyspepsia, constipation, and liver complaints. It reduces the resistance of cells so much that diseases like typhoid fever, consumption, pneumonia, smallpox, and measles can find an open door into the system.

5. **Complications.** — Uric acid complicates functional disorders, particularly those of the excretory organs. It interferes with the action of the skin, lungs, liver, intestines, and kidneys, as already stated. It makes a sallow, or swarthy skin, destroys complexion, obstructs perspiration, capillary circulation, and absorption; it may make a torpid liver, and cause stomach or intestinal indigestion, or consti-

pation. Uric acid lessens the power of sensory or motor action, and even interferes with cerebral action. In all these troubles, there is a marked tendency to make the functional disorder chronic.

6. **Prevention.** — Prevention consists in the most careful attention to the various steps by which uric acid is made; by preventing each step in its place and time, the condition as a whole will be prevented. First, there must be no intoxication, and no excessive use of alcohol; then one must take plenty of vigorous exercise in the open air, eat only nourishing and easily digested foods, never overeat even for once, keep digestion perfect, avoid the use of all drugs except for functional needs, avoid excitement, great strain, or worry, and sleep eight to nine hours each night.

7. **Cure.** — The condition once well established in the system, curing it is a difficult task. It consists in the most rigid preventive measures, the stimulation of cells to do their work, and increasing all the excretions of the body. All preventive measures must be carried out in detail under the eye of a skillful physician; at the same time a nerve tonic, and gastric and liver stimulants to increase the work of these organs, may be given; the heart must be regulated and capillary circulation improved. Then all the avenues of excretion must be opened up, and the excretory organs must be aroused. Daily baths, both for thermal effect and for cleanliness, are necessary to put the skin in good condition; the kidneys should be flushed, the bowels kept open and regular, and the lungs kept clear, healthy, and strong.

OUTLINE SUMMARY

1. *Uric Acid* — defined.
2. *How Made.*
   1. Source.
   2. Cure.

3. *Effects.*
    1. Attacks tissues.
    2. Aids other diseases.
4. *Diseases it will Aid* — give list.
5. *Complications* — functional disorders.
6. *Prevention* — give list of steps.
7. *Cure* — difficult — general health.

CHAPTER LXI

DENTAL HYGIENE

1. The Oral Cavity. — The oral cavity, or mouth, is composed of a number of parts, some of which exercise a very great influence upon the vitality, resistance, and health of the body; among these are the teeth, gums, cheeks, tongue, hard palate, and soft palate. Dental hygiene consists in the proper care of these organs.

2. A Clean Mouth. — Unless the mouth is kept perfectly clean, an abundance of bacteria may be found there, and several diseases are known to start from that point. Whatever food is left in the mouth ferments or decays, furnishing a lodging place for germs and producing a foul breath; poisons thus made find their way into the stomach, and are sent to all parts of the system. It is necessary to keep the mouth perfectly clean at all times, or a whole train of troubles will follow. A clean, healthy mouth has as much to do with good health as a good stomach or a good liver. A foul breath is usually the result of a filthy mouth.

3. Deformity of Teeth. — The first permanent tooth to appear is the first molar. The proper care of this tooth is of prime importance, because its direction, shape, size, and symmetry affect the line up of the other molars, also, later, the cuspids, bicuspids, and incisors. If the teeth fit properly, the upper jaw will develop with normal breadth

and height, giving proper space for the nasal chambers and for palate growth. This insures good breathing. The early loss of the first molar will cause the crowding together of the other teeth, narrow arches, and deformity of the jaws. The lower jaw may protrude, giving the face a long, narrow appearance. A mouthful of irregular, jumbled, jagged teeth not only spoil one's looks, but make proper chewing of the food impossible. By proper care early, teeth should be made to fit like the parts of a perfect machine.

4. **Teeth and Respiration.** — Breathing is influenced by the development of the jaws. When the arches are narrow, and nasal chambers contracted because of ill-shaped jaws, breathing is bad. Impaired respiration results in a poorly developed chest, lowered vitality, and sometimes tuberculosis and death. A contracted chest and reduced vitality make it easy for pneumonia to get a start. Thus death itself may come as the culmination of a series of bad results due to ill-fitting teeth.

5. **Teeth and the Nervous System.** — Impaired digestion due to a bad mouth produces ill effects upon the nerves, such as poor nourishment and poisons. It is well known that reduced nerve power may be caused by bad breathing due to narrow nasal chambers. The strain of pain from diseased teeth affects the nerves, breaks up attention, and depresses both body and mind. Neuralgia often results from long exposed nerve ends due to carious teeth. Poisons and fermented substances from bad teeth are swallowed, and sometimes aid in bringing on neurasthenia.

6. **Rigg's Disease.** — Pyorrhea, or Rigg's disease, is an inflamed or ulcerated condition of the alveolar membrane of the socket of teeth, or dental periosteum. Its primary

cause may be a granular substance called *tartar*, which collects on teeth not properly cleaned. The grains of tartar work in between the teeth and gums, and by the mechanical action in chewing, break the adhesion of the gums and teeth; they cause the gums to inflame and ulcerate. The gums swell, become spongy, and bleed easily. Later the teeth become loose, and finally come out. This disease will never appear if the teeth be kept perfectly clean all the time; but when it once gains a firm hold, it is almost incurable. The poisons resulting from this disease play an important part in some other dangerous diseases, besides materially affecting the general health.

7. **Cleaning the Teeth.** — All dirt and filth should be kept out of the mouth. Dirty paper money, pencils, metals, and dirty fingers, should never be put into the mouth. The teeth should be washed two or three times a day, and polished once a day. The teeth of infants should be cleaned first with a cotton swab, and later with a small paint brush. A good powder like precipitated chalk should be used in brushing the teeth, then the mouth should be well rinsed with cold water. Teeth should not be brushed crosswise, but lengthwise, and always brushed away from the gums; they should be brushed inside and outside, and the bristles of the brush pressed well into the crevices between the teeth. The brush and powder should be kept as dry as possible, and the final rinsing should be followed by the use of some good mouth wash. The grinding surfaces of all molars should be brushed well, and the tongue itself should have a few strokes of the brush.

8. **Antiseptic Mouth Wash.** — There are many good antiseptic mouth washes. Almost any druggist or dentist can give reliable information on this point; there are

also a number of good proprietary preparations, while many are not only worthless, but harmful.

Liquor Antisepticus (U. S. P.) in half strength, listerine (Lambert's) diluted, and glycothymoline are good. The mouth should be carefully washed just before retiring. The bad taste and foul breath of the morning are usually due to filthy teeth that were not cleaned on retiring. Fermentation goes on undisturbed while we sleep. To overcome the acidity of the saliva of some persons, the mouth should be rinsed with some alkaline wash just before retiring, as milk of magnesia, or lime water.

OUTLINE SUMMARY

1. *The Oral Cavity* — mouth; influence on health; parts.
2. *A Clean Mouth* — importance; germs; decaying food; foul breath.
3. *Deformity of Teeth* — care of first molar; irregular teeth; effect on health.
4. *Teeth and Respiration* — narrow arches; bad breathing, lead to disease.
5. *Teeth and the Nervous System* — bad teeth; bad digestion; neuralgia.
6. *Rigg's Disease* — inflammation; caused by tartar; caused by lack of care.
7. *Cleaning the Teeth* — mouth; kept clean; teeth brushed.
8. *Mouth Wash* — ask dentist; use before retiring.

CHAPTER LXII

BLINDNESS

1. Prevention. — There is not, perhaps, a more pitiable misfortune than the loss of one's sight. Blindness may be caused by many things, most of which are comparatively simple. But as much as 90 per cent of all blindness is caused by one or two diseases which may be entirely prevented with proper care. If trachoma and ophthalmia neonatorum could be prevented, cases of total blindness would seldom occur.

2. Defective Cornea. — Blindness from defective or injured cornea is not frequent; it may be caused by inflammation, tumor, or injury.

FIG. 82. — Testing the eyes.

There are several forms of inflammation of the cornea, the principal ones being (1) the vascular, (2) suppurative, and (3) ulcerative.

The vascular form of inflammation usually accompanies trachoma, and is the result of friction by roughened lids; if not checked, it will impair or destroy vision; it may be cured by removing the cause and treating the rough surfaces, or by a surgical operation.

In suppurative inflammation there is a loss of substance of the cornea and the formation of pus between the layers; it is usually started by some injury in which germs gain an entrance; it should not be permitted to run on very long. The treatment consists in the application of antiseptic lotions; sometimes surgery is necessary.

An ulcerative condition of the cornea may arise from a number of causes; it usually results in perforation, or clouding of the cornea, greatly impairing the sight or destroying it altogether. The treatment consists in antiseptic lotions and hot fomentations, and at times the

application of atropine to prevent adhesions. A surgical operation called iridectomy will sometimes relieve the condition.

The cornea is subject to several tumors, some simple, others malignant; simple tumors can usually be destroyed by cauterizing, while the malignant ones require a surgical operation. Any tumor of the cornea is serious, and should have an early treatment.

Most injuries of the cornea are in the form of wounds, or burns. In case of wounds, the eye should be carefully cleansed and given an antiseptic dressing. Burns by powder, acids, lime, and other alkalies frequently occur; in all cases the eye should be cleansed quickly and a remedy applied; a solution or an ointment of boric acid will be found useful. Care must be taken to prevent adhesions. If wounds or burns are serious, an eye specialist should be called.

3. **Muscular Paralysis.** — Blindness may be caused by paralysis of the muscles of the iris, resulting in closing the pupils. This, like any other paralysis, requires both local and general treatment. It is not of frequent occurrence, but is serious. It can be overcome only by clearing up the paralysis, which is usually difficult to do.

4. **Cataract.** — Cataract is due in a majority of instances to some interference with the nutrition of the lens. The treatment is nearly altogether surgical. Cataract should have early treatment, and when in competent hands, should seldom if ever cause blindness; but if neglected, it will, in many cases, either permanently impair the sight or produce blindness.

5. **Shrinking of the Optic Nerve.** — Atrophy, or shrinking, of the optic nerve is due to a number of causes, as diseases of the brain, disease of the retina, optic neuritis,

Bright's disease, injury, and poisoning. The cause, if known, should be removed, and the general condition of the patient improved as much as possible. Strychnine in increasing doses is sometimes helpful, but frequently treatment is of no avail. It sometimes results in partial blindness, but total blindness is the usual result.

6. **Glaucoma.** — Glaucoma is the name of a series of symptoms, the chief of which is an increase in the tension of the eyeball. There are two varieties, primary and secondary. Primary glaucoma refers to tension originating in the eye itself; secondary glaucoma is the result of some inflammatory process or lesion in some other parts of the system. Tension may increase until it results in total blindness, with or without pain. The treatment is both medical and surgical. Medical treatment is most effective in primary glaucoma, and consists in hot applications, and in the instillation of solutions of eserine or pilocarpine. Surgical treatment consists usually in performing an iridectomy. In absolute glaucoma with pain, the eyeball should be taken out.

7. **Trachoma.** — Granulated lids, or trachoma, appear as enlarged blood vessels, the conjunctiva being studded with small elevations, separate at first, but later uniting and forming large hard masses, which irritate the cornea and produce ulceration.

There are two forms, simple and ulcerative. Simple trachoma is not contagious, is usually caused by strain and cured by proper treatment. Ulcerative trachoma is contagious, and affects all ages and classes, but is most commonly seen in children and in the uncleanly. It usually appears in the lower classes where sanitation is bad. It runs a chronic course and shows little tendency to recovery except under careful treatment. It is perhaps caused by a germ,

but may be caused by long continued use of some medicines, as solution of atropine.

In the treatment, the first thing is absolute cleanliness; otherwise medicines will do but little good. The eye should be bathed in salt water or a solution of boric acid; then crystals of sulphate of copper, of alum, or of the pure or mitigated stick of nitrate of silver, should be applied to the surface of the conjunctiva. Solutions of nitrate of silver, acetate of lead, and sulphate of zinc are also employed. Individual granules may be removed by use of nitrate of silver. Ulceration from this cause should be treated as when appearing from any other cause. Surgical treatment consists in opening the granules and removing the contents; then the surface should be brushed with a solution of bichloride of mercury, 1:500, or 1:1000. The after-treatment consists in keeping the eyes clean by frequent bathing with some mild antiseptic lotion, and the use of mild astringents.

This disease, which is one of the two causing so much blindness, can be entirely prevented by observing the rules of ordinary cleanliness and simple disinfection. Everything used by a patient should be disinfected, and the clothing, books, and toys of an infected child should not be used by other children. Ordinary disinfectants are sufficient in this disease, and all articles needing disinfection can be handled in the usual way.

8. **Ophthalmia Neonatorum.** — This disease is one of the most severe forms of inflammation of the conjunctiva. It is a specific infection due to a well-known germ. The incubation period is from thirty-six to forty-eight hours, sometimes longer. The disease runs a long, tedious course, and frequently affects the cornea and causes loss of vision. It may attack the new-born infant, adult of middle age,

and even the aged. This disease is the cause of more blindness than all others combined.

The disease in a short time after the entrance of the germ begins with an irritation and redness of the conjunctiva; the lids become somewhat red, swollen, and glued together; a rather thick, purulent discharge appears, and the lids sometimes puff, resembling two soft-shelled eggs; the discharge becomes thinner, and more abundant; the patient loses appetite, becomes more restless and is in considerable pain. In many cases, haziness of the cornea appears, followed by ulceration, perforation, and blindness. In some cases, violent from the first, there is total destruction of the cornea. There is total loss of vision in about one third of all the cases where treatment is not begun in the earlier stages. In many severe cases there is a sort of false membrane formed.

The treatment of this disease is both preventive and curative. The preventive measures to be employed are (1) to thoroughly cleanse the eye of a new-born infant, and (2) instill one or two drops of a solution of nitrate of silver. In former practice a two per cent solution was used, but later experience shows a one per cent solution to be sufficient, perhaps. Excess of nitrate of silver in the eye may be neutralized by the use of salt in water. Boric acid solution, salt water, and bichloride of mercury in strength of 1 : 4000 to 1 : 5000 are used, but nitrate of silver has given best results. In the adult, care should be taken not to take the germ from one eye to another.

The medical treatment consists in means to destroy the germ, reduce inflammation, and heal the wounds. During the acute stage, cold applications and a mild antiseptic should be used, such as a solution of boric acid. Nitrate of silver should be introduced early, if not in the acute stage, certainly in the subacute. Great care should be

taken to prevent sloughing, or ulceration, of the cornea. Good nursing and a strict adherence to the treatment will cure the disease.

This disease is very contagious, but by care, good sanitation, and disinfection, can be prevented entirely. It is not so difficult to cure when the treatment is thorough and begun in time; but when it reaches the advanced stages, it is almost incurable; blindness from this cause is hopeless.

CHAPTER LXIII

MODERN SURGERY

1. **A Modern Art.** — Surgery, which, in its present form is saving the lives of thousands every year, was unknown to the ancients. Even in modern times it was first crudely practiced by barbers; it was then taken up in a scientific way by physicians, and cultivated to a high degree of perfection. The ancients could not practice surgery because they knew but little anatomy, and nothing of anæsthesia or antisepsis. When they attempted a major operation, the patients could not often stand the great pain, and those who could bear the pain usually died of sepsis, because the physicians did not know how to dress wounds properly.

2. **Anæsthetics.** — Surgery took on scientific form upon the discovery of anæsthesia, a state of sleep in which the patient cannot feel the pain of the wound. This sleep is produced by drugs, and is so sound that the head can be cut open and a part of the brain removed, or the body opened and some internal organs taken out, and the patient never feel it. Ether and chloroform are the best anæsthetics, and are now used in all civilized countries.

3. **Asepsis and Antisepsis.** — An *aseptic* drug is one that destroys the poison made by germs, and prevents it from

injuring the body; an *antiseptic* drug destroys the germ itself. By the use of such drugs in dressing a wound, it is now possible to heal a wound without a drop of pus, the yellow matter that usually appears in a wound and makes it a running sore. It is now known that pus is caused by the action of germs that get into a wound, and that it should not exist in a wound at all. The older surgeons used to think that pus was necessary in healing, and that it showed a healthy state of the wound; but if pus appears now in a wound made or dressed by a surgeon, the surgery is not good. The surgeon must keep bacteria out of the wound, and it will heal in a very short time, without becoming a running sore.

4. Preparing a Patient. — For an important operation, the patient must fast for about two days and nights, so as to have the alimentary tract empty and clean; he is then given one or two good baths, and dressed in suitable clothes that have been sterilized. A few minutes before the operation, he is placed upon a movable table supported by wheels, so it can be pushed about easily; then he is given an anæsthetic and put to sleep for the operation. The anæsthetic must be given by a physician who can know the patient's exact condition all the time; if a little too much is given, it will kill the patient. When the patient is ready, the table is wheeled into the operating room, which is especially prepared for the purpose, being well lighted, sterilized, and supplied with every appliance for good work.

5. The Operation. — Only a few persons are admitted to the operating room; there are the head surgeon, one or more assistant surgeons, the physician who gives the anæsthetic, and a nurse or two, usually. No company is ever allowed. The surgeons and assistants thoroughly

sterilize their hands and instruments, and put on white sterilized suits and caps. The area of the wound on the patient's body is sterilized like the hands of the surgeon, and the blood vessels near the wound ligated to prevent much flow of blood; then the incision is made with a surgeon's knife, and the blood that flows from veins and spurts from arteries is quickly stopped by closing the ends of the cut vessels. The surgeon removes whatever the wound is made for, as a tumor, a cancer, or a bullet, then closes the wound by stitching, sterilizing, and dressing. The patient is wheeled out, put to bed, and carefully nursed until his wound heals. It usually takes but a few minutes to perform even a large operation.

6. **Operable Cases.** — Whenever a disease has localized in the form of a tumor, an inflammation, or a growth, or when a limb is broken beyond repair, or a foreign body so lodged as to interfere with the normal function of an organ, and medicines applied or taken will not relieve, and also when the disease is more dangerous than the operation, the case is regarded as operable. It is also essential to get the patient's consent to the operation, if he be capable of giving consent; if he is unable, then the consent of his guardian or nearest relatives must be obtained.

7. **Relation to Medicine.** — Medicine and surgery are very closely related. Surgery is intended to do what medicine cannot do, or would take so long to do that the life of the patient would be endangered. In this, surgery is a great aid to medicine; it is in reality a specialized branch of medicine proper. It is employed when a radical course is to be pursued; it is especially useful in treating those wounded upon a battlefield, or in an explosion in a mine, or in a railway wreck, where limbs are to be amputated, foreign bodies removed, and hemorrhage

stopped; it is equally useful in all abnormal growths, as tumors and cancers.

8. **Training a Surgeon.** — A good surgeon should be well educated in medicine first, then pursue a special course for the practice of surgery. He should be a man without any form of dissipation, or he can never attain that delicate skill necessary to handle a surgeon's knife. He should see all the famous surgeons operate, and have a long systematic training in the practical work of some large hospitals, until he is perfectly familiar with every detail of his work. He must have a steady nerve, a trained eye, and a clear, quick mind. He must never let anything confuse him, and be prepared always for the unexpected, as the life of a patient depends upon his skill. Many men trying to practice surgery are *butchers*, not *surgeons*. It requires a very high order of talent to make a great surgeon.

9. **Achievements.** — The results which surgery has attained border on the marvelous. Surgeons can open the head and remove a tumor, or even a part of the brain, and the patient get well; the body can be opened, and all important organs examined, some of them removed, and all sorts of internal wounds dressed and abnormal growths treated; gallstones can be taken out, a kidney can be opened or taken out, the liver, stomach, or intestines treated, and the appendix cut off, and the patient not only live through it, but be well and strong afterwards. They actually open the eyeball, the middle ear, or the throat, and straighten crossed eyes, with operations that are comparatively harmless. They can take out a piece of the intestines, break up all sorts of adhesions, and cure strictures.

PRACTICAL EXPERIMENTS

CHAPS. I–IV. 1. *To show Animal Matter:* Put a tablespoon of hydrochloric acid in a quart of water; put in this the long bone of a chicken leg. In a few days take the bone out. It can be tied in a knot. The mineral matter has been taken out by the acid.

2. *To show Mineral Matter:* Put a bone in a fire and burn it until it is white, then remove and let it cool. It is light and very brittle. The animal matter has been burned out.

3. *To show Structure of Bones:* Saw a long, fresh bone lengthwise. All the parts may be seen: the periosteum, compact tissues, cancellous tissue, and marrow may be pointed out.

4. *To illustrate Joints:* Get from a butcher a large joint; remove its parts one by one. Note how strong it is; also, the ligaments, synovia, synovial membrane, cartilage, and ends of the bones; also how the bones move in the joint.

5. *To test the Strength of the Bone:* Procure a long bone, a short bone, and a joint; try to crush them with a heavy weight; then try to break them with a blow of a hammer. Saw out a cube of bone, and test it in the same manner. Compare the strength of a fresh bone and a dry bone.

6. *To show the Marrow:* Boil a bone for a short time; saw it lengthwise on both sides to the marrow; the marrow can be taken out whole; note how greasy it is; it is composed chiefly of fat.

7. *To show how Bones Ossify:* Boil or cleanse the bones of the leg of a pig or lamb. The line of union between shaft and head of bone may be seen. A sharp blow will separate the parts at the line of union. The head of bone is not yet ossified, the process still going on.

8. *To find the Air Cavities:* Cleanse and dry thoroughly the skull of any domestic animal, as the cat or dog; break skull into small pieces carefully, and note the cavity in the mastoid processes, and those above the eyes in the frontal bone, and in the upper jawbone.

CHAPS. V–VI. 9. *To illustrate Levers:* Levers are of three classes: first, second, and third; they have, besides the bar, three elements: the power, fulcrum, and weight; in a lever of the first class, the fulcrum is between the power and weight, as in prying up an object one uses a lever of the second class when lifting a weight with a bar, and a lever of the third class when lifting a fishing pole to draw a fish out of water. Show how long bones act as levers, giving examples of each class, and that any bone may be a fulcrum, and muscles the power.

10. *To illustrate Tendons:* Cook thoroughly a leg of some animal like a cat or chicken, and dissect it; remove the skin and examine the attachments of large muscles, the upper ones being broad, and the lower ones gradually tapering into tendons; also the manner of contraction and the great strength of tendons. Note the advantages. Remove tendons and note changes.

11. *To show Arrangement of Muscles:* Boil a leg of a lamb, pig, or chicken; remove the skin, and dissect the muscles, one by one, beginning with the tendon, and tracing each muscle to its upper attachment. From a manikin or a cut in the text, trace in like manner the great groups, and the larger single muscles of the body.

12. *To show the Great Strength of Muscles:* Dissect an entire muscle with its tendon; fasten the tendon to the hook of a pair of spring scales, and attach a weight to the large end of muscle; increase weight until the muscle is torn in two, making note of the weight required. Compare this with the known lifting power of the muscle before death, and note the difference.

13. *To show Structure of Muscles:* Boil thoroughly a piece of beef or pork tenderloin; its fibers will fall to pieces; note their covering, the character of the fibers, shape of fibers, and mechanical arrangement.

14. *To show how Muscles Contract:* Remove the skin from a rabbit, beginning at the neck, and move the joints of legs in a natural manner; observe how the muscles enlarge and harden as they contract; observe the same changes in the movement of your own arm. Explain how the cells change their shape.

15. *To show Difference in Voluntary and Involuntary Muscles:* Put under the microscope the fibers of a piece of cooked tenderloin, and some bits of the gizzard of a fowl, and note the difference in size, shape, and arrangement of fibers; make a comparison of the cells.

16. *To determine Comparative Rate of Voluntary and Involuntary Muscular Movement:* Most persons have some tremor, or palsy, of muscles; let such person hold in unsupported hand a piece of paper, and count vibrations. Then have person try to make same motions and count; note the difference, and explain the excess of involuntary movements. In a voluntary movement of this kind, two sets of muscles have to be used alternately.

CHAPS. VII–XIX. 17. *To show Structure of Teeth:* A good way to see all parts of a tooth is to grind it lengthwise to the pulp; then the enamel, dentine, cement, pulp, and nerve cavity may be seen; grinding crosswise at crown and fang will show well the parts of these points.

18. *To test Sugar:* Dissolve a tablespoonful of sugar in two ounces of water; add a few drops of Fehling's Solution; the mixture will turn yellow. On adding Fehling's Solution to an ordinary mixture containing sugar, the mixture will turn yellow.

19. *To test for Grape Sugar:* To an ounce of a mixture supposed to contain grape sugar, add about a dozen drops of a solution of sulphate of copper, and a few drops of a solution of potassium hydrate, which any druggist will prepare; boil the mixture; it will turn a brick-red color if grape sugar is present.

20. *To test for Starch:* Heat in water the mixture supposed to contain starch, and then add a few drops of tincture of iodine; if starch is present, the mixture will turn blue. Some skill is necessary to get results; a little too much of either the mixture or tincture may spoil it. The starch in almost any food may be found in this way.

21. *To show Grains of Starch:* Scrape a small quantity of starch from corn, potato, or beans; place mass on glass slide, add a few drops of diluted tincture of iodine, and place under microscope; the grains can be seen.

22. *To show Action of Saliva:* Mix some starch and saliva in a bottle; heat, add a few drops of Fehling's Solution, and then boil; the mixture will become yellow, showing the presence of sugar, which has been produced by the action of saliva upon the starch.

23. *To test the Action of Saliva:* In chewing a bit of wheat bread, or raw grain, retain the morsel in the mouth for a moment, and notice that its taste becomes somewhat sweet. This is caused by the action of the saliva on the starch in the grain; it converts starch to sugar.

24. *To show Action of Gastric Juice:* It is not always easy to get gastric juice for experimenting. A good substitute may be made by mixing some water, pepsin, and a few drops of hydrochloric acid. Put some fibrin, white of an egg, or milk, in a glass, and add some of the mixture. The albumin will soon dissolve and form a permanent, clear liquid, containing albuminoid, like that made in gastric digestion.

25. *To show Action of Pancreatic Juice:* Pancreatin may be used as a substitute for pancreatic juice. Mix some warm water and starch, and add a small amount of pancreatin; this will convert some starch into sugar; employ test for sugar; when the reaction produces the yellow color, we know pancreatin has converted starch to sugar.

26. *To make an Emulsion:* Mix about a half glass of water and some castor oil; shake until a white fluid is found. The oil has been broken up into very fine particles, which are suspended in the water, making an emulsion. The same result may be more easily secured by adding a small amount of pancreatin to the mixture of oil and water, and then shaking vigorously until a milklike fluid is found, which is an emulsion.

27. *To show the Action of Bile:* Any butcher can supply a gall bladder of a beef, filled with gall. Mix a small amount of sweet almond oil and oleic acid; add sufficient gall, and shake well. The result is an emulsion. This requires much more of the gall than other ingredients.

28. *To show Absorption through Membranes:* Carefully remove about a square inch of the shell of an egg at one end without breaking the inner lining of the shell; make a small opening in the other end of the egg, and keep the hole up; holding the egg between thumb and finger, place it in a glass of water, just far enough to immerse the end from which a portion of the shell was removed. In a few minutes water will pass through the unbroken lining at the lower end of the egg and force the contents of the egg out at the top.

29. *To show General Absorption:* Give a kitten a good dinner of cream; in two hours kill it quickly with chloroform, open the abdomen and take out intestines; the white fat already emulsified will be found passing through the lacteals, and can be traced by its milklike appearance.

30. *To illustrate Osmosis:* Fill the bladder of a hog with a solution of salt, and immerse it in a bucket filled with a solution of sugar; in a short time it will be found that the two solutions have in part at least exchanged places. It can be more quickly seen if the two fluids be tinted with different colors; they exchange places by passing through the walls of the bladder, both endosmosis and exosmosis going on.

31. *To separate Starch:* Grate a raw potato, spread the mass on a cloth, and compress the fluid through the cloth into a tumbler. Let it stand awhile, and the starch will settle to the bottom. Pour the water off and apply the iodine test; the white substance is starch. Or, the starch in wheat dough can be washed out by kneading it under water; it will settle as above; the water can be poured off and the iodine test applied.

32. *To test for Minerals in Water:* Boil a few drops of water in a clean glass vessel, or on a smooth, flat glass surface, and note the white stain remaining; notice the lining that gradually accumulates in a teakettle.

33. *To test Purity of Water:* (*a*) Place a glass of water in the open air for a few days; if an odor develops, the water is bad. (*b*) Put some pure sugar in a glass of water and leave it open for a few days; it will turn yellow if the water contains organic matter. (*c*) Dissolve a small amount of permanganate of potassium in some distilled water. Add some of this solution to the water to be tested, enough to give it a pink tint. If the water contains organic matter, the pink tint will fade out in a few hours; otherwise, it is free from organic matter. (*d*) Microscopic test for bacteria, sediment, and other impurities. (*e*) "Nessler's test"; put a few drops of Nessler's solution in a half glass of water; if a yellow or brown color is produced, the water contains organic matter and is dangerous.

CHAPS. XX–XXIV. 34. *To show Structure of Heart:* Get the heart of a sheep or pig, leaving two or three inches of the vessels attached; immerse in water for a few days, then remove the pericardium and dissect, taking off one coat at a time; in this way the structure of the heart can be accurately shown.

35. *To observe the Beat of the Heart:* Examine the heart beat of a student before the class, and note rate, force, and frequency; examine the beat of the heart from both the front and back of chest, by placing

the ear against the body. Note the increase in the beat from running, or some calisthenic exercise.

36. *To show Structure of Arteries:* Secure some pieces of the larger veins and arteries from a butcher; compare them. Test strength and elasticity by stretching them; observe valves in veins, and the smooth, glistening inner surface of the arteries.

37. *To show the Structure of the Veins:* Run the finger along a vein in the arm, toward the hand, and note that the blood does not follow; this shows the action of the valves; push the finger along some prominent vein of the hand, in opposite direction to flow of the blood; the finger pushes the blood out of the vein. After the finger passes a valve or two, it will be observed that the blood may follow the direction of the finger to a valve and stop at that point; this shows, again, the action of the valves.

38. *To show the Flow of the Blood:* Place the finger on a prominent vein in the back of the hand; notice that when the blood is pushed out of the vein, it remains empty for a time, as the valves prevent the backward flow of the blood. From this experiment, both the direction and rate of the flow may be shown.

39. *To show Clot and Fibrin:* Secure an ounce or two of fresh blood from a butcher; clotting will soon take place; put the clotted blood in a clear, glass bottle, and add water, shaking it vigorously; the water will be red in a moment with red corpuscles. Pour the water off, and repeat the process until the water is practically clear. The edges of the remaining material become white, and later, almost the whole mass can be cleansed of its red color. This remaining mass is called fibrin.

40. *To show the Serum of the Blood:* Secure an ounce of blood of any animal, and place it in a saucer or some other shallow vessel for a few hours; after clotting has begun, serum will begin to separate, and later it may be poured off from the remaining mass.

41. *To show Capillaries*: Destroy movement of a frog with ether, but do not kill it; cleanse its foot, and spread the web over a hole in a piece of cardboard about the size of a dime, fasten it firmly, and place it under the microscope. The movement of the blood in the capillaries can be easily seen, and also the passage of the blood cells; a large cell will be seen to dilate the walls of the capillaries as it passes through.

42. *To show Location of Arteries:* Wherever there is a pulse beat, an artery is located; pupils should be instructed that at the joints large arteries are easily found, on the side toward which the joint bends. All the chief arteries should be pointed out to the pupils, having them locate the arteries by their pulse, and learn their names.

43. *To show Red Corpuscles:* Stain the slide of a microscope with human blood; make the stain slight; place it under the microscope, and the red corpuscles may be seen; note the size and shape of the corpuscles; make similar stains with the blood of various animals, and compare corpuscles with those of human blood. The human corpuscle will soon be recognized by peculiarities of shape and absence of nuclei.

44. *To show White Corpuscles:* Take the white matter from a pimple which is about ready to open, and make a stain on the slide of a microscope; on placing this in the microscope, white corpuscles may be readily seen. Notice the nuclei; some of the cells have more than one nucleus; add a drop of acetic acid to the stain, and notice change in color of the cell. The white cells can frequently be found mixed with the red cells in the blood; this requires very careful work and a good microscope.

45. *To show Effect of Alcohol on Blood Cells:* Put a small amount of alcohol on a blood stain for the microscope; notice that the cells at once shrivel and change their shape; this is because the alcohol has taken most of their water from them.

46. *To show the Effect of Water on Cells:* Place a small drop of water on the blood stain of the slide in the microscope, and note the effect on the red blood cells. At first, they will sometimes appear to enlarge, but later they always shrink.

47. *To make a Tourniquet:* Place a handkerchief around the limb containing a wound, and tie it tightly in a double knot. Then turn the knot inward, so as to make it rest on the bleeding vessel; put a short stick through the loop of the handkerchief on the opposite side from the wound and gently twist until the knot on the opposite side compresses the walls of the bleeding vessel, and closes it. In the case of a bleeding artery, the handkerchief should be placed between the wound and the heart; in a bleeding vein it should be on the opposite side from the heart.

CHAPS. XXVI–XXIX. 48. *To show Mechanics of Breathing:* Borrow a glass funnel from a druggist, and tie a piece of sheet rubber securely over the mouth of the funnel; attach a little rubber balloon to the end of a piece of glass tubing; pass the tubing through a cork that will fit the tube of funnel tightly; pass the balloon and a part of the tubing through the tube of the funnel, and fit cork so as to make the funnel air-tight. If the rubber on the mouth of the funnel be drawn downward a short distance, the air will descend the glass tube and enlarge the balloon just as it inflates the lungs; also, if one blow in the glass tube and inflate the balloon, the rubber over the mouth of the funnel will bulge outward.

49. *To show the Action of Cilia:* Cilia may be shown by scraping the epithelium from the mouth of a cat, dog, or frog, and placing same under a good microscope; they may be seen in same manner also upon the cells of a gill of a fish.

50. *To show Structure of Trachea:* Get trachea and larynx of some animal from a butcher; remove trachea and examine its construction; observe the epiglottis and vocal cords; observe also the size, its parts, and the cartilaginous rings.

51. *To show Structure of Bronchi:* Take trachea and lungs from some animal, insert a glass tube in the trachea, and inflate the lungs; tie off the trachea tightly, and leave the lungs inflated for some time, placing them in water; then open and examine the bronchi; dissect them with a knife, and trace their course; observe structure.

52. *To show Tissue of Lung:* Remove lungs of a frog, inflate them, and tie them off tightly. Let them dry well, and examine tissue. Inflate and dry the lungs of a cat or small dog, and examine structure in same way; then cut them to pieces carefully and examine each part.

53. *To show the Structure of Lungs:* Get the lungs of some animal from a butcher, and keep the trachea attached; pass a glass tube through the glottis, and inflate the lungs to their full capacity. After they have remained some time in this condition, cut off a portion of the lungs, and observe its light weight; put a piece in a basin of water, and observe that it floats; note color, structure, vessels, and tissues.

54. *To show how Chest Increases by raising the Ribs:* Place about the chest a tape line, taking an accurate measure. Raise the ribs, as in breathing, and note difference in size. Raise and lower the

ribs several times, and note variation. Make the test on different pupils; have the pupils make some tests.

55. *To show Contents of Expired Air:* Blow the breath through a glass tube into a glass of clear limewater, and let it bubble up through the water; the water at once becomes milky; this proves that carbon dioxide is in the breath; the gas combines with the lime and forms a white precipitate. The moisture in breath may be shown by blowing against a cold window pane, and the heat of the breath shown by blowing against the palm of the hand when it is cold.

56. *To illustrate Abdominal Breathing:* In proper breathing, the chest expands several inches, and there is but little expansion at waist; in abdominal breathing there is little or no expansion of chest, but much expansion of abdomen. Make test with tape, measuring just under the arms, and at waist.

57. *To show Action of Diaphragm:* The diaphragm is moved by the action of the phrenic nerve, which may be readily seen. Kill a cat with chloroform, open body, remove lungs so as to have room. Locate nerve of diaphragm, and by pricking it, the diaphragm can be made to move.

58. *To illustrate Artificial Breathing:* Using one boy as a patient, illustrate the three methods given in the text, and have the pupils practice them until all can do them. Point out the differences between them, and name the advantages of each.

59. *To show Change from Venous to Arterial Blood:* Cut a thin slice from the inside of a thick piece of beef, and expose it to the air. Its color will change from dark venous blood to a bright red. This is due to oxygen in the air. The same may be shown by keeping venous blood in a liquid state and exposing it to the air for a few minutes.

60. *To show Harmlessness of Carbon Dioxide:* This gas is comparatively harmless, except as it prevents oxygen from reaching the lungs; inhale it, and note that it does no injury; it is taken into the stomach in soda water without harm; it merely escapes at first opportunity.

61. *To show Movement of the Air:* By the flame of a candle one can test the direction of the current at the keyhole, the grate, in small openings at bottom and top of window, or any crack in the room; the flame will show the air entering the room at openings low down,

usually, and escaping at cracks and openings higher up. The same may be shown by a cloud of dust, or the movement of dust in a sunbeam.

62. *To illustrate how to Ventilate:* By using the windows of a schoolroom, illustrate all the methods of ventilation mentioned in the text. If at all convenient, take the children to inspect the system of heating and ventilation of some large public building, and have them make some drawings of same.

CHAP. XXX. 63. *To show Relation of Blood and Temperature:* Exercise one arm vigorously and rapidly for a few minutes, and note that the veins fill, and temperature rises in the arm. The two go together; this increase in circulation is called forth because of the extra waste from the exercise, and heat is the result of the oxidation that accompanies it.

64. *To show Effect of preventing Circulation:* Compress an artery, and the parts supplied by it lose heat; tie a string tightly around a finger, and note that venous blood collects, the color of the part becomes dark, and the finger feels cold.

65. *To show how Circulation affects the Sensation of Cold:* Take a cold bath in the morning of a cold day, and get a good reaction; when the capillaries are filled with warm blood, heat is restored, and the body will be warmer all day; a cold footbath in the morning will keep the feet warm all day for the same reason. Hold a piece of ice in the hand, the arteries contract, and there is a feeling of cold. All these cases show how much the sensation of cold depends upon the amount of blood in the capillaries.

66. *To show that the Sensation of Cold depends upon Evaporation:* Water evaporates from cotton goods rapidly, and from woolen goods slowly. Wet woolen hose will appear much warmer than wet cotton ones, because evaporation from the woolen goods is so slow.

67. *To show Effect of Color upon the Sensation of Cold:* Put a black glove on one hand and a white glove of same goods and weight on the other, and note the difference in sensation of cold. In warm weather wrap a piece of ice in a black cloth, and another in a white cloth of same material and weight. The ice in black cloth melts faster.

CHAPS. XXXI–XXXIV. 68. *To show Cells of Epidermis:* Scrape from the skin of the hand some of the outer layer; gather the mass and place it under the microscope; the cells can be readily seen. Another good way to get a collection of epithelium cells is to bathe the hands in hot water; a collection of cells can be rubbed off with a cloth and placed under the microscope.

69. *To show Cells of Hair:* It must be remembered that the cells of the outer layer of a hair overlap like the shingles of a roof; in rolling a hair between thumb and finger, it has a longitudinal movement in the direction of the root of the hair; it slips endwise between the fingers while the rolling is going on, because of the overlapping cells.

70. *To develop a Frog from a Tadpole:* Place the tadpole in a basin of water, and observe changes; in the course of time a complete transformation takes place. Have the children make drawings illustrating the changes.

71. *To show Loss of Weight:* Weigh an average boy in the morning; have him, without eating or drinking, do his work and engage in his sports throughout the day; weigh him again at night, and note the loss of weight.

72. *To show Insensible Perspiration:* Touch the blade of a cold razor with the fingers, and note that moisture collects upon the blade; the same may be seen by taking in the hands a cold lamp chimney, as spots of moisture will gather wherever the fingers touch; the oil of the fingers may be shown in the same manner.

73. *To show Structure of the Kidney:* Secure from a physician a microscopic section of the kidney; place under the microscope, and notice wonderful structure; observe capillaries, arteries, veins, and tubes, and note the character of its cells.

74. *To dissect the Kidney:* Secure a kidney of a pig from a butcher; put it in water and keep it there for several hours, then dissect by cutting it open from end to end; note the different parts of the organ, its vessels, tubes, pocket, and its drain pipes; continue by tracing its vessels to their extremities.

75. *To illustrate the Use of Sewage:* Sewage is a fine fertilizer; the moment the waste products of the body reach the ground and air, they are taken up to become the food of plants. A simple illustration

is seen in the use of the excrement of animal bodies for fertilizing the beds of plants; this waste material ceases to be obnoxious, but soon becomes clean, and is turned to an excellent use as food for plants.

76. *To show Structure of the Skin:* Secure from a physician a good microscopic specimen of skin; place it under the microscope, and notice structure; observe its layers, the cells in the different layers, its vessels, its papillæ, and its pigment cells.

77. *To show Structure of Hair:* From same source as above, get a specimen prepared to show the follicles and structure of the hair; place it under the microscope; note the glands, muscles, and cells; observe the spiral, and the direction of growth.

78. *To show Structure of Nails:* Take a very thin specimen of finger nail; wash it perfectly clean and place it under the microscope. It will appear almost transparent; it may be colored, and the character of its cells shown.

CHAPS. XXXV–XL. 79. *To show Types of Brain:* To find the different types of brain, specimens of the brains of common animals, the fish, frog, and others, should be hardened for comparison; they may be hardened by placing them in alcohol, Müller's fluid, or formalin, for a few days; in removing the brains of animals, make an opening in the cranium and pour in all the alcohol or Müller's fluid the brain will take up; this will harden it so it can be removed without being torn to pieces. After several brains have been secured, note difference in size, structure, and parts.

80. *To show Structure of the Brain:* Secure the head of a small animal, as the rabbit or squirrel; open cranium and remove the brain; if care is taken, the brain can be removed without a break. Place it in alcohol for a few days, to harden it enough to be studied. Make transverse sections until all parts of the brain are shown. If possible, get from a physician a few good specimens for the miscroscope, and study the structure of the brain in that way.

81. *To show Structure of the Spinal Cord:* Secure the backbone of a pig, cut it into sections of three or four vertebræ each; saw open these sections lengthwise, and a very good means of studying the structure of the cord will be afforded; note the membranes and branching of the nerves, the arrangement of white and gray matter;

dissect its parts. Observe closely the roots of the spinal nerves and ganglia.

82. *To show the Sympathetic System:* Dissect a frog or cat; open abdomen carefully, from end to end; by carefully removing viscera, the two chains of ganglia and their connecting fibers can be seen along the spinal column in front.

83. *To show the Sciatic Nerve:* Dissect the leg of a cat, and the sciatic nerve can be traced; the same can be traced in the leg of a frog; note its size, membranes, and its sensitiveness.

84. *To show Structure of the Nerve:* It is rather difficult to show the structure of a nerve without the use of a microscope; secure a good longitudinal section and a transverse section of the nerve; place these under the microscope, and note the nerve fibers, observe nerve cells, cells of fat, arrangement of parts, and the nerve sheath; observe also the connecting tissue and make good drawings.

85. *To show the Sensitive Nature of Nerves:* Overcome a frog with chloroform; having destroyed sensation, cut off a foot and irritate the sciatic nerve; note the movement. This is well shown also in toothache and earache; touch an exposed nerve in the cavity of a tooth with needle, and note sensation; or strike the nerve commonly called the "crazy bone."

86. *To show the Contraction of Nerve:* Kill a frog or cat with chloroform, cut off a portion of the leg, and irritate the stump of the sciatic nerve, and note movements. Contractions of muscles will follow.

87. *To show Sensibility of Skin:* Touch soles of the foot gently with a feather; touch the body at other points in the same way, and observe difference in sensation; touch with the points of a compass different parts of the body, and note the sensation of distance between the two points.

88. *To show Sense of Temperature:* In moving gently the tip of one's finger, when it is cold, over a surface of the body, differences of temperature may be noted; it is more noticeable by using some hard object of different temperature from the body. Some portions of the skin are much more sensitive to cold than other portions. When a nerve for a temperature sensation is touched, the amount of cold seems greater.

89. *To illustrate a Reflex Act:* Remove the head of a frog, drop a bit of acid upon its body, and note the effort made to remove it with the foot; put its toes against a hot iron, and note that it will draw the foot away; the knee jerk, which can be performed by any one, is a good example of the reflex act, as also the sudden closing of the eyelids when exposed to great light.

90. *To show Difference in White and Gray Matter:* Secure a specimen from a physician and examine it with a microscope; note difference of the cells, and make drawings of the same.

91. *To show Structure of the Membranes of the Nerves:* Dissect the cranium of a cat and pull out carefully all the membranes of the brain; note the difference of appearance and structure. Dissect the spinal column and carefully remove the membranes of the cord, making minute examination.

CHAPS. XLI–XLV. 92. *To show Structure of the Eye:* Secure an eye from a butcher and dissect it slowly; first remove its muscles and conjunctiva; dissect the eyeball, removing the outer coat and the cornea; note carefully the properties of these parts; then dissect the optic nerve, and observe the way it enters the eye; find the yellow spot; finally remove the lens and other humors of the eye. The specimen can be preserved from day to day, as the work progresses, in alcohol or Müller's fluid. It is well enough to secure several specimens and preserve them for different dissections. If nothing better is at hand, they can be preserved in water for several days.

93. *To focus Light:* Any ordinary magnifying glass will serve to illustrate. Compare the photographer's camera with the eye, as dissected in Experiment No. 92. Make a simple camera, and illustrate its lenses and other parts.

94. *To illustrate an Image on the Retina:* Take an ordinary round, deep hat box; puncture a small hole in the bottom, paste over the open top a greased paper; holding the top of the hat box near the eye, and covering the head with some dark cloth, direct the small hole in the bottom toward some object, as a house or tree. The reflection of the object will appear upon the greased paper. This will illustrate the making of an image on the retina.

95. *To illustrate the Field of Focus:* Fix the eye on a line of print and count the letters or words that can be seen distinctly at one look

without moving the eyeball. It will be seen that véry few can be clearly imaged. This is called the "field of focus." The objects that can be clearly seen are within a small circle. There is a large field outside of this, more or less dimly lighted, in which objects can be outlined but not always recognized.

96. *To show Duration of Impression:* Spin a square block like a top. It will appear round. The turning of a square shaft makes it appear round, and the rapid revolving of a wheel will make its spokes appear as if they are one solid piece.

97. *To illustrate Exhaustion of Retina:* When the retina is well-nigh exhausted, an image made remains for a time, because the retina is not able to quickly adapt itself to a new vision. The images thus remaining are called "after images." Look steadily at a white spot on a black ground, or a black spot on a white ground for a few moments. On turning the eyes away, and looking at another object, the spot just seen will appear and remain for a moment. This is due to an exhausted condition of the retina.

98. *To show Color Blindness:* By "color blindness" we refer to that condition by which the eye is unable to take up a given color. In instances when the eye gazes steadily for a time at a bright red in good light, and then turns to a red object of much lighter tint, it may be wholly unable to see the tint, and the object may appear to be green. This merely shows that the eye is unable to image the lighter tint of the color, but is able to take up tints of another color. This is "color blindness." Make tests of color blindness among pupils by exhibiting shades of the various colors.

99. *To illustrate "Chromatism":* Look at an object through a magnifying glass and against the sky; a border of color will appear. This is called chromatism. This is corrected by the use of an additional lens. It is corrected in the eye, so that as an optical instrument the eye is the most perfect known.

100. *To illustrate Dilation of Pupil:* Have a pupil enter a very dark room. When he comes suddenly into a bright light, note how large is the pupil of his eye; then have him gaze at a very bright light for a moment, and note how small the pupil has become. The same can be seen by experimenting on the eye of animals in the light and dark.

101. *To illustrate Nearsightedness:* Hold a magnifying glass in front of the eye; notice that the position of objects is changed. They may be brought nearer or appear farther away, according to the shape of the lens used.

102. *To show Farsightedness:* This is best shown by the use of two magnifying glasses. They refract the rays of light and make an object appear farther or nearer, according to the strength of the lens.

103. *To illustrate Blending Views:* Fix both eyes on a small object about two feet away. Close one eye, making careful note of the image produced by the other eye; then close the eye just used, opening the one before closed, and note the difference in the image. The two eyes make their images from different points. Then look at the object with both eyes open and note changes. The images made by the two eyes are now blended and appear as one. This is true of a good vision. Placing a book edgewise before the eyes, it will be noted that the right eye makes an image of the right side of the book, and the left eye makes an image of the left side. When both eyes are open, the blended image is made.

104. *To illustrate Double Vision:* Place a lead pencil in front and about two feet away. Place another pencil of different color in line with the first, but four feet away. On looking at the first pencil with both eyes, there will be a double image of the second pencil; on looking at the second pencil with both eyes, there is a double image of the first pencil. This illustrates "double vision."

105. *To illustrate "Phosphenes":* By pressing upon the eyelids with the hand, or gently stroking the eyeball when the lids are closed, rings of light appear. When one is struck in the eye with a ball, or some similar object, radiating light sometimes appears. This is due to disturbance of the optic nerve.

106. *To show Illusions of Size:* Cut two pieces of paper of exactly same size and shape, one being black and the other white. A square is perhaps the best form for this. Paste the black square on a large sheet of white paper near the center; paste the white square on a sheet of black paper in like manner. Compare the size of the two images. The white square will appear to be larger. One dressed in white clothing appears larger. This is a strange but interesting illusion of sight.

107. *To show the Blind Spot:* Refer to description of the blind spot given in the text. Make two black spots about a foot apart on a sheet of white paper, holding the paper about two feet from the face. Close the left eye and fix the right eye on the left spot. Gradually move the paper to or from the face until the spot disappears. The image has fallen upon the blind spot of the right eye, which is incapable of making an image.

CHAPS. XLVI–L. 108. *To show Structure of the Ear:* Nothing but a human ear will convey a correct idea of this delicate organ, but a fairly good idea may be formed by the dissection of the ear of a calf. Saw the outer bones until the canal of the ear may be opened; observe carefully the tympanum, the middle ear, with its parts and membranes; the internal ear may be dissected, and while its parts are very small, a fairly good idea may be obtained.

109. *To locate Auditory Nerve:* Dissect the petrous portion of the temporal bone of a human skull, and the foramen of the auditory nerve may be seen.

110. *To hear Sound through the Mouth:* Place a small watch in the mouth and close the lips; the ticking of the watch can be distinctly heard through the Eustachian tube.

111. *To show Sympathetic Vibration:* Make a loud shout near a musical instrument, as a piano; the sound wave, or wave of the air, will set a string of the instrument to vibrating; it will be found that the string which is of the same pitch as the shout, is the one that vibrates.

112. *To illustrate the Telephone:* Construct two boxes with vibrating ends; oyster cans with both ends removed will serve the purpose; the vibrating end or membrane may be made by stretching some sheet rubber over the end of the can; connect these vibrating membranes with a string of any ordinary length, say fifty feet; speaking in the open end of the can will set the membrane vibrating; the vibration moves along the string to the other can, and sets its membrane to vibrating in a manner to reproduce the vibrations of the first can.

113. *To show the Work of the Eustachian Tube:* The Eustachian tube is a collapsed tube; when one swallows, a little air is forced through the tube to the middle ear; it may be seen by closing the

nostrils and swallowing; the sensation felt in the ear is produced by the air passing through the tube and into the middle ear.

114. *To show Disturbance of the Semicircular Canals:* Whirl around on the heel several times, and then try to walk in a straight line to a given object; it will be found that the equilibrium of the body has been disturbed; this is brought about by disturbing the brain, which affects the semicircular canals; the same effect may be had sometimes by sitting in a swing or hammock, or riding backward on a car.

115. *To show Structure of the Tongue:* Procure the tongue of an ox. Examine its surface, its papillæ, and dissect it into its various parts; then examine the tongues of pupils, bringing the tongues well forward; this may be done by catching the tongue between the thumb and fingers in a napkin or handkerchief; examine the papillæ, especially the row of large projections at the back of the tongue. Examine a cat's tongue and make comparison.

116. *To test the Taste:* To test the taste in different parts of the tongue, place either a sweet or sour substance on the different taste areas, and note the difference in the degree of taste.

117. *To show Construction of the Nose:* Very little of the human nose can be seen with the naked eye, in life; a very good idea of the structure of the nose may be obtained by dissecting the nose of a calf or some other domestic animal. Examine the surface, the parts, membranes, and openings; note the connection between the nose and pharynx.

118. *To make Distinction between Taste and Smell:* The best way to make this test is to blindfold a person and close nostrils with the finger and thumb, put some odorous article of food in the mouth, and have person determine what it is without the aid of the nose; an onion is a good article with which to make the test. It will be found that the odor of many an article is mistaken for the taste.

119. *To distinguish between the Sensations of Touch at two Different Points:* The old experiment so well known to every student of physics is sufficient: Cross the first and second fingers, and place between the ends, while crossed, a marble or a bullet; it will appear that we are touching two separate objects; a little practice is necessary to perform this experiment properly.

GLOSSARY

Ab do'men, the large cavity of the body situated below the diaphragm.
Ab'scess, a collection of dead matter within living tissue.
Ab sorp'tion, the process of taking substances into the tissues.
Ac com mo da'tion, change of the shape of the lens of the eye to make the image fall upon the retina.
Ac cu'mu late, to collect in a mass, as the dead material of an abscess.
Acid, a substance generally sour, and chemically opposed to alkali.
Ad'e noids, spongy growths in the upper pharynx.
Ad'i pose, fat, as found in animal bodies; unrendered lard.
A dul'ter ate, to make less pure, or, to make impure.
Af fin'i ty, a strong attraction of one substance for another.
Al bu'men, the white of an egg; a proteid substance.
Al bu'min, the name of all proteids.
Al'co hol, an intoxicating drug produced by the fermentation of sugar.
Al'i ment, food composed of proteid, sugar, or fat.
Al i men'ta ry, pertaining to food, as the organs engaged in digesting foods.
Al'ka li, a substance which is the chemical opposite of acids, as soda and lime.
Am œ'ba, the smallest known animal, composed of only one cell.
Am y lop'sin, a ferment in pancreatic juice; it changes starch to sugar.
A næ'mi a, a condition of the blood in which there is a deficiency of red corpuscles.
An æs the'si a, a loss of sensation or a state of sleep, as for a surgical operation.
An æs thet'ic, a substance that will cause a deep sleep.
A nas to mo'sis, the branching and reuniting of blood vessels.
An'i mal char'coal, boneblack used for making shoe polish and in refining sugar.
An'ti dote, a substance which will prevent the action of a poison.
An ti sep'tic, a substance which will destroy bacteria and prevent rot.
An ti tox'in, a substance which will destroy the poisons of disease.
Ap'o plex y, a brain disease usually caused by pressure.
Ap pa ra'tus, instruments and appliance for performing experiments.
Ap pen'da ges, minor objects or parts that belong to or are added to something else.
Ap pen di ci'tis, an inflammation of the appendix.

Ar'sen ic, a metallic poison.
As phyx'i a, a state of unconsciousness caused by lack of oxygen.
As sim i la'tion, the process by which the cells take up food.
As tig'ma tism, a defect of the eye in consequence of which rays from one point are not brought to a single focal point, thus causing imperfect images.
As trin'gent, a substance that contracts the tissues.
Au to mat'ic, pertaining to self, as automatic action; self-action.
Ba te'ri a, the smallest known plants, composed of only one cell.
Bi chlo'ride of mer'cu ry, a poisonous chemical; one of the best of disinfectants.
Bile, a yellowish green waste substance produced by the liver.
Ca nal ic'u li, made up of little canals.
Can'cel lous, composed of pores, or resembling honeycomb.
Cap'il la ry, a fine hairlike tube.
Cap'sule, a closed sac inclosing a substance.
Car bo hy'drate, a food in which carbon is the chief element.
Car bol'ic acid, a poisonous chemical which destroys tissues by burning; a disinfectant.
Car'bon, the chief element of coal.
Car'di ac, pertaining to the heart.
Ca'se in, that part of the albumin of milk that forms clabber.
Cat'a ract, a clouding of the crystalline lens of the eye.
Ca tarrh', a disease in which there is an excessive flow of mucus.
Ca thar'tic, a remedy for clearing the intestines.
Cel'lu lose, a substance forming framework of most vegetables.
Cem'ent, a covering of the root of a tooth which holds the tooth in its socket.
Ce ru'min ous, pertaining to wax; name of glands of external ear.
Cer'vi cal, pertaining to the neck.
Chaf'ing, an irritation due to the rubbing together of moist surfaces.
Chap'ping, cracking of the skin due to exposure to moisture and wind.
Chlo'ral, a poisonous substance which produces sleep.
Chlo'ro form, a drug which produces a deep sleep; used for medical and surgical purposes.
Chol'e ra, a dangerous disease of intestines.
Cil'i a, hairlike projections of some cells lining the trachea and bronchi.
Co ag'u late, changing a liquid to a solid with a different composition.
Co'ca, a plant from which cocaine is obtained.
Con ges'tion, a state in which the blood vessels are too full.
Con nec'tive tis'sue, coarse tissue supporting fibers and cells.
Con'scious ness, the state of knowing one's own mental actions.
Con ta'gious, diseases that can be caught by the touch or through the air.
Con tam'i nate, to render impure.
Con trac'tion, a shortening, as the contraction of muscles or of rubber.

Con vo lu'tions, ridges between the furrows of the brain.
Cor'pus cle, a minute cell, as a blood corpuscle or a lymph corpuscle.
Cor'tex, the outer layer, as in the brain or kidney.
Cos met'ics, materials for dressing and coloring the skin.
Cra'ni um, the bones which inclose the brain.
Cra'zy bone, not a bone, but the nerve exposed at the elbow.
Cross eyes, eyes drawn inward until the lines of vision cross.
Crys'tal line, composed of or like crystals; name of principal lens of the eye.
Cyst, an abnormal growth within healthy tissue, usually hard and inclosed in a corpuscle.
De cay', a process of rot due to action of bacteria.
De gen er a'tion, decay, decline, or dissolution.
Deg lu ti'tion, the act of swallowing.
De lir'i um, a state of unconsciousness, or insane mind, wandering.
De lir'i um tre'mens, a nervous and mental disease due to excessive use of alcohol.
De o'dor ant, a substance that will destroy an odor.
Di'a phragm, a muscular, fibrous membrane which separates the thorax and abdomen.
Di as'tol e, relaxation of the heart to be filled with blood.
Di'et, the process of choosing proper foods in both states of health and sickness.
Dif fu'sion, a uniform mixture of fluids, as in gases.
Di ges'tion, the changes in food to prepare it for the cells.
Di late', to enlarge, to widen, or distend.
Di lute', to weaken or lessen, as in making a drug weaker.
Dis in fect'ant, a substance that will destroy disease germs.
Dor'sal, pertaining to the back.
Draft or **draught**, a strong current of air, as through an open window.
Drop'sy, a uniform swelling to accumulation of serum.
Duct, a channel or tube.
E lim i na'tion, the removal of waste materials by intestines, kidneys, skin, and lungs.
E mo'tions, mental states, as love, hate, anger, sorrow, etc.
E mul'si fy, to break up into very small particles.
E mul'sion, a fluid containing very small drops of floating oil or fat.
En do car'di um, the lining of the cavities of the heart.
En do the'li um, a thin membrane of epithelium lining serous cavities.
En'er gy, a force used to do work; the energy of the body comes from oxidation.
Ep i the'li um, a layer of cells covering the surface of the skin, mucous and serous membrane.
Er y sip'e las, a disease of the skin caused by bacteria that enter a wound.
E'ther, a drug used to produce a deep sleep, used for surgical operations.

E vap o ra'tion, passing off as a vapor or a gas.
Ex'cre ment, refuse material thrown off by excretion.
Ex cre'tion, discharge from bowels, kidneys, and skin.
Ex pec'to rate, to cough up and spit out, as mucus from mouth and lungs.
Far'sight ed ness, a defect of the eye in which the image falls behind the retina.
Fa tigue', the feeling attending exhaustion of cells; excess of waste over repair.
Fer'ment, a substance which causes fermentations, as yeast.
Fer men ta'tion, the process of changing organic substances to a new substance by means of a ferment.
Fi'ber, a small thread of tissue composed of cells.
Fi'brin, a substance composed of strings or threads of albumin formed in the coagulation of blood.
Fil tra'tion, process of purifying a liquid by straining it through a porous substance, as sand.
Flat'u lence, gas in the stomach or intestines due to indigestion.
Fo'cus, the point where rays of light are brought together.
Food, anything that promotes the life of the cell or aids it in its work by giving heat, weight, and energy.
Ful'crum, the pivot upon which a lever turns.
Func'tion, the natural use or action of an organ.
Gall, bile stored in the gall bladder.
Gas'tric, pertaining to the stomach.
Gel'a tin, an albumin taken from connective tissue and bone.
Glu'cose, the sugar of the grape; it may be manufactured.
Gly'co gen, a kind of starch produced from sugar by the liver.
Gout, a painful disease, with some inflammation of the joints.
Gym na'si um, a room and appliances for systematic physical training.
Hawk'ing, slowly forcing mucus from the throat with the breath.
Hem o glo'bin, a coloring matter in the red blood corpuscles.
Hem'or rhage, flow of the blood from a broken tube.
He pat'ic, pertaining to the liver.
His tol'o gy, the science of the cells of animal and vegetable tissues.
Hy dro car'bons, foods whose chief elements are carbon and hydrogen.
Hy'dro gen, a substance which united with oxygen forms water.
Il'e um, lower part of small intestines.
Il'i um, broad, expanded bones of the hip.
Im'ag es, pictures upon the retina or in the mind.
Im merse', to surround an object completely with a fluid.
In fect', to taint with disease germs.
In gre'di ent, a definite part of a mixture or chemical compound.
In sal i va'tion, mixing saliva with food in chewing.
In'stinct, a natural inclination to act in a given direction.

In tes'tin al juice, a fluid secreted by the glands of the lining of the intestines.

I'ris, the muscular curtain behind the corner of the eye.

Ir'ri tant, an agent that destroys cells or causes inflammation.

Jaun'dice, a disease caused by deficient excretion of bile.

Lab'y rinth, a system of intricate passages, as in the internal ear.

Lach'ry mal, pertaining to tears.

Lac'te als, fine lymphatic tubes that take up fat from the intestines.

Laud a num, a poison made of opium and alcohol.

Lead'ers, the common names for tendons.

Lens, a transparent body having the power to change the direction of rays of light passing through it.

Le'ver, a strong bar which may move about a fixed point called a fulcrum.

Lig'a ment, fibrous bands of connective tissue.

Lig'a ture, a narrow bandage to control flow of blood.

Lu'bri cate, to smooth with oil or other substances in order to prevent friction.

Lymph, a milky fluid composed of surplus food and waste from the cells.

Ma la'ri a, a disease caused by poison which may be carried by a species of mosquitoes.

Ma lig'nant, very poisonous; also cancerous.

Malt, a ferment made from barley, which changes starch to grains of sugar.

Ma'ni a, a form of mental activity in one line, amounting to insanity.

Mas ti ca'tion, the act of chewing.

Me a'tus, a passage; a tube or canal.

Mel an cho'li a, a form of mental depression amounting to insanity.

Mem'brane, a thin tissue usually used for a covering or lining.

Mer'cu ry, a silvery metal, liquid at ordinary temperatures, used for medicine and mechanical purposes.

Mi'cro scope, an optical instrument for seeing very small objects, as cells and bacteria.

Mor'phine, a drug made from opium; an alkaloid of opium.

Mu'cus, a fluid secreted by the mucous glands.

Nar cot'ic, a substance which benumbs the nerves and causes sleep.

Na'sal, pertaining to the nose.

Nau'se a, sickness at the stomach with tendency to vomit.

Near'sight ed ness, a defect of vision when the image falls in front of the retina.

Nerve, a fiber composed of nerve cells.

Neu'tral ize, to oppose and overcome.

Ni'tro gen, one of the elements of common air.

Nu cle o al bu'min, a kind of albumin which contains iron.

Nu'cle us, the central mass of a cell having vital powers.

Nu tri'tion, the process of assimilating foods by the cells.

O don'toid, toothlike ; name of the process of axis on which the head turns.
Oil, a fluid with fat as its chief ingredient.
Old'sight ed ness, a functional defect of the eyes due to age.
O le o mar'ga rine, an artificial butter made from tallow, lard, etc.
O paque', dark, cloudy, as smoked or frosted glass.
O'pi um, a narcotic drug from the juice of a species of poppy.
Op'tic, the name of the nerve of sight ; pertaining to the eye.
Or'bit, a cavity, the bony cavity containing the eye.
Os mo'sis, diffusion of fluids through membranes ; passage of two fluids in opposite directions through same membrane.
Os si fi ca'tion, the turning to bone by deposit of bone cells.
Ox i da'tion, burning ; changes caused by union of substances with oxygen.
Ox'y gen, an element of both air and water.
Pain, the aching of a nerve due to pressure, tearing, or exposure.
Pal pi ta'tion, a functional disorder of the heart.
Pan cre at'ic juice, the juice secreted by the pancreas.
Pa pil'læ, small projections, usually containing a nerve end.
Pa ral'y sis, loss of the power of motion due to disease, pressure, or severing of motor nerve or its center.
Par e gor'ic, a mixture containing opium.
Pep'sin, a ferment of the stomach; it changes albumin to peptones.
Per i car'di um, the membraneous bag surrounding the heart.
Per i stal'tic, the wormlike motion of the stomach and intestines by which the food is reduced to smaller particles and moved forward.
Per i to ni'tis, inflammation of the peritoneum.
Per spi ra'tion, passage of water through pores of the skin.
Pig'ment, a coloring matter; it makes freckles, color of hair, and the color of dark races.
Plas'ma, the liquid portion of the blood.
Pleu'ra, the lining membrane of the thorax.
Plex'us, a kind of network of nerve cells.
Pneu mat'ic, pertaining to the air, or respiration.
Pneu mo'ni a, a disease of the substance of the lungs.
Poi'son, a substance that prevents the action or destroys the life of the cell.
Po'ten cy, amount of vital energy.
Proc'ess, a projection ; also a manner or system by which a thing is done.
Pro'te id, a food element which forms tissue.
Pro'to plasm, the albuminous substance forming the body of all living cells.
Pty'a lin, the active principle in saliva which changes starch to sugar.
Pulse, the wave in the blood caused by the beating of the heart.
Pus, a creamy, poisonous matter which flows from an abscess. It is composed of dead corpuscles, dead tissue, and other waste materials.
Pu tre fac'tion, the process of decay of animal tissue due to the action of bacteria ; it is usually accompanied by bad odors.

Qui'nine, a bitter white drug made from the cinchona tree.
Quin'sy, an acute form of tonsilitis.
Ra'di at ing mus cle, a muscle whose fibers extend in all directions, from a point in the center.
Res'i due, the remainder of a substance after a chemical action.
Re stor'a tive, a curative remedy to restore a disturbed function.
Rheu'ma tism, a constitutional disease affecting either the joints or muscles, usually due to the collection of fluids.
Rick'ets, a disease of bones due to lack of mineral matter.
Sar co lem'ma, a sheath of the striped muscular fiber.
Sci at'i ca, an inflammation of the sciatic nerve.
Scur'vy, a disease due to improper foods.
Se ba'ce ous, pertaining to oil; name of oil glands of the skin.
Sed'a tive, a remedy that soothes or reduces excitement.
Se'rum, a watery portion of animal fluids, as in the blood, the fluid of a blister and of dropsy.
Si'nus, a cavity, as the sinuses of the brain or frontal bone.
So lu'tion, liquid containing dissolved matter.
Spine, the backbone; a sharp, projecting point.
Spore, a small body, formed in certain organisms, and by germination giving rise to a new organism.
Starch, a food element composed of carbon, hydrogen, and oxygen.
Ste ap'sin, a ferment found in the pancreatic juice; it emulsifies fat.
Ster'il ize, to cleanse of all bacteria that produce disease.
Stim'u lants, chemical and physical agents that increase the natural activity of cells.
Stim u la'tion, increase of the natural activity of cells by chemical or physical agent.
Strych'nine, a nerve stimulant made from the seed of a shrub.
Su'gar, a food containing carbon, hydrogen, and oxygen.
Tan'nic acid, an acid containing tannin, and used as an astringent.
Tan'nin, a substance found in the bark of many trees.
Tape'worm, a species of worm which develops in the intestines and resembles a piece of white tape.
Tem'per a ture, the degree of heat within a body; sometimes used to indicate fever.
Ten'don, a hard, strong, fibrous cord, an extension of a muscle.
Theine, the active principle of tea.
Tho'rax, the upper cavity of the body containing the heart and lungs.
Thy'mus gland, ductless gland beneath the breastbone and just above the heart.
Thy'roid gland, ductless gland in the front part of the neck.
Ton sil i'tis, an inflammation of the tonsils, sometimes called quinsy.
Ton'sils, two oval bodies in the back part of the mouth, one on either side of the opening of the pharynx.

Tox'in, a poison formed within the body, usually in the putrefaction of albuminous matter.

Trans fu'sion, transfer of the blood from one person to another.

Tri chi'na, a small worm living within the flesh of the hog. When pork is not thoroughly cooked, the worm may enter human flesh and cause disease.

Tryp'sin, a pancreatic ferment which changes albumin to peptone.

Tu ber cu lo'sis, a disease caused by the tubercle bacillus ; consumption.

Tu'nic, a lining membrane or coat.

Tym pan'ic membrane, the ear drum.

Tym'pa num, the middle ear.

U're a, a crystalline waste substance ; one of the ingredients of urine ; it is soluble and the final product of proteid decomposition.

U re'mi a, a disease in which urinary matter appears in the blood.

U re'ter, a tube leading from the kidneys to the bladder.

Vac ci na'tion, inoculation with cowpox to prevent smallpox.

Va'gus nerve, tenth pair of cranial nerves, the pneumogastric.

Valv'u læ con ni ven'tes, semicircular folds in the lining of the small intestines.

Vas'cu læ, containing small vessels or tubes.

Vas o mo'tor, nerves that cause contraction or dilation of the arteries.

Ven ti la'tion, the process of replacing foul air with pure air.

Ven'tri cle, a cavity.

Ver'te bra, any one of the twenty-four bones that compose the spine.

Ves'sels, a term usually applied to the blood vessels collectively.

Ves'ti bule, a sort of entrance or hallway, the central part of the internal ear.

Vil'lus, a minute projection on the surface of the intestines.

Vi tal'i ty, potency, energy, or quantity of life.

Vi'tal knot, nerve center that regulates breathing.

Vi'tal proc'ess es, all physiological actions that sustain life, as circulation, breathing, digestion, and nervous action.

Vom'it ing center, a nerve center that controls the act of vomiting.

Whey, thin residue after the removal of the curd and cream of milk.

Wor'ry, a state of mental distress or fretting which is very destructive to nerve force.

Yel'low spot, the point of most perfect vision, in the exact center of the retina in the rear, and about one twenty-fourth of an inch in diameter.

INDEX

Willis, J.C.
Elementary physiology.

NAME	DATE	NAME	DATE